The Acquisition of Liquids

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1. Introduction

1.1. Purpose and Hypotheses

This thesis concerns the acquisition of liquids (l and r) by a number of children. The purpose of the investigation was to go beyond the surface substitutions to discover the phonological processes which would account for these substitutions and all the intermediate steps in the acquisition of the sounds involved.

The hypotheses were 1) that there are a few basic processes taking place in children's acquisition of liquids, 2) that acquisition can be accounted for by a model (proposed by David Stampe) which says that these processes are innate and are gradually limited and suppressed in acquisition, 3) that the changes taking place in the speech of children speaking other languages (French and German in this case) should vary according to the types of liquids found in these languages, and 4) that if the processes are phonetically plausible, they will be operating in languages of the world, and thus, evidence for them should be found in historical or dialectal change.

1.2. Methods

The data for the first four children was collected in 1968-70, and was gathered at regular interviews at the homes of the children. The interviews were approximately two hours long and took place two or three times a month. A few tape recordings were made, but most of the data were written in phonetic transcription as spoken by the child. The interviews were "free" in that no real attempt was made to get the children to talk. Usually I simply listened as the children were playing and transcribed their utterances. Sometimes I had them look at picture books with me and tell me the names of objects. Imitated forms are not included. Data for Emily Salus come from her father, and data for Jennifer Stampe come from David Stampe. The data for Joan Velten, Hildegard Leopold, and Edmond and Charles Grégoire come from the books or articles by the fathers of these children.

For each of these children all the words which should have contained liquids were collected and organized according to the

laws is that fricatives presuppose stops, i.e. the intermediately close fricatives presuppose the maximally close stops, which afford greater contrast to the vowels. Therefore, fricatives are acquired only after stops have been acquired. These laws and the principle of maximal contrast govern the step-by-step development of the phonemic system. At each progressive stage, neutralizations of certain oppositions are suspended, and thus the phoneme inventory increases.

Sounds may be allophones before they become phonemic. For example, Jakobson (1968) says that often a narrow and more front vowel (e.g. [ɛ]) appears in the beginning simply as a variant of the fundamental vowel [a], which is either optional (papa may vary with pɛpɛ) or combinatorial: usually [a] after labials, [ɛ] after dentals. But as soon as both vowels become separate phonemes, "the child attempts to intensify the difference of wideness and [e] is narrowed to [i]."

Similarly, Velten (1943) says that in the 25th month [ɪ] appears as an allophone of short [u] before dentals (first in sɪt, 'sit') in accented syllables. Accordingly, fut 'foot', dud 'good', bus 'bush', futs 'fix', etc. change to fɪt, dɪd while fup 'whip', fub 'swim', etc. retain [u]. But the phonemic opposition (u/ɪ) is not established until the 36th month.

Now these analysis are clearly wrong. A child who acquires a high vowel, e.g. [i] does not substitute this for the [ɛ] allophone he may have used for [a]; rather the [ɛ] remains an alternate of [a], and the new [i] represents vowels distinct from either [ɛ] or [a]. A child does not change dɛdɛ 'dada' to didi upon acquiring [i]! Similarly, Joan Velten's allophone [ɪ] for [u] as in fɪt 'foot', did not "become" a phoneme. Upon acquiring the [ɪ]-phoneme distinct from [u], the vowel of fɪt reverted to [u]. Jakobson and Velten's mistake was possible only because they ignored the substitutions that were being made.

Since Jakobson analyzes the child's system as a separate entity, without reference to the adult system, the child's phonemic system may at any point be non-congruent with the adult system. This means that the child may have phonemic distinctions not found in the adult system. For example, an English child may have a vowel length distinction.

The special difficulty with this type of analysis is that it is nearly impossible to get the substitutions, and thus the processes, from the data. Substitutions cannot be gleaned from the phoneme system, although the phoneme system can always be deduced from the substitutions. Velten does give a few equational-type statements such as "p/b for English [p, b, v-]" (Velten 1943), but these are of little help, especially since he chooses very few exemplary words, and does not attempt to give many of the "homonyms" represented by a form. The model makes such statements as these mere optional footnotes to the description.

The model which followed in this paper differs greatly from those outlined above. It is that proposed by Stampe (1969).

In Stampe's view, the child's pronunciation is derived from his mental representation of adult speech. This mental representation corresponds approximately to the adult surface pronunciation and is the child's underlying representation. An innate system of phonological processes operates on this representation. The innate system expresses the full system of restrictions on speech: a full set of unlimited and unordered phonological processes. Thus in early stages when all of these processes are applying in unordered fashion, simple sequences like dadada, mamama appear. Each new phonetic opposition the child learns to pronounce involves some revision of the innate phonological system. Changes in the child's phoneme inventory are merely one of several secondary effects of a change in the system of processes. The mechanisms of revision are suppression, limitation, and ordering: thus, the child's task in acquiring adult pronunciation is to revise all aspects of the system which separate his pronunciation from the standard. If he succeeds, the resulting system will be equivalent to that of standard speakers (444). The child's closer approximations of adult pronunciation are seen as reflecting his limitations or suppressions of those processes which are not common to the adult system.

According to Stampe, there is no need to refer to implicational laws such as Jakobson proposed. The regularities in the order in which phonetic representations are mastered can be explained by independently attested properties of the innate system (its processes, their inner hierarchies, and their interrelations) and by the three mechanisms whereby the innate system is revised (445). Moreover, there may arise contradictions to the order of acquisition predicted by the implicational laws. Jakobson, being interested only in the phoneme system, can ignore such problems by interpreting the implicational laws in terms of phonemic representation. Since he does not have to account for contextual variation, he can disregard context-sensitive processes which may contradict his implicational laws. The inventory is set up without regard for neutralization in some of the forms as long as sounds are phonemic elsewhere. It follows that the implicational laws cannot even account for the phonemic representation, but only for the phonemic inventory. Stampe says that these implicational universals are actually just innate universal phonological processes which govern phonetic (not underlying) representation and which have to be ordered for acquisition. The child has to unlearn those not appropriate to his language.

Jakobson claims that the child may create an opposition which does not exist in the adult language, but this is impossible if the child has the adult system underlying. Stampe sees no evidence that the child has a phoneme system of his own. In fact there is counter evidence; see my remarks above on the claim that the child converts allophones to phonemes. It appears that the child has internalized a representation which transcends his own productions and forms the base on which the innate system of processes operates.

position of the liquids in the words. Then I tried to find the regularities and substitutions, and ultimately the underlying processes. This was done for the English-speaking children first. Then I analyzed the data for the French and German children to find out what underlying processes were operative in their speech. I expected to find that as the types of liquids varied, the subsequent substitutions (and thus the forms of underlying processes) would vary also.

Last, I looked through some books on language families and phonetic change for evidence of the same basic processes in historical or dialectal change. This was not intended to be an exhaustive search, but rather a random sampling. If my processes were phonetically plausible and natural, I assumed that they would be operative in some adult languages, as evidenced by phonetic change.

1.3. Model

This study differs from most concerning acquisition. First, it differs from the traditional studies which consist of vocabulary lists and atomistic listing of substitutions. These are patterned after Neogrammarian grammars. For such studies (e.g. Leopold 1939) each word is given in phonetic transcription, and the words are listed in alphabetical order along with the dates at which they appeared. This survey of word acquisition is very detailed and inclusive, but no attempt is made to generalize and integrate the data. In fact, Leopold states that it is too early to attempt generalizations, and thus he limits himself to the task of recording. He does tabulate the child's representation of standard sounds and gives some "rules" of sound substitution, but these rules are only superficial substitutions and changes (such as assimilation). There is no attempt to analyze substitutions like z → š into their constituent processes, in this case devoicing and palatalization. In spite of the detail of such studies as Leopold's, they require reanalysis because they do not connect parallel phenomena and do not reveal generalizations.

Second, my study differs from those inspired by Roman Jakobson. These studies usually consist of a statement of the child's successive "phoneme inventories." According to Jakobson (1968), the child's task is to master the system of phonemic oppositions. The principle in operation is that of "maximal contrast." The first opposition is a maximally open phoneme, e.g. /a/ versus a maximally closed one, e.g. /p/. Then the first consonantal opposition is that of nasal and oral stop, followed by the opposition of labials and dentals, and so on. The chronological succession of these acquisitions is surprisingly uniform. This is because it agrees exactly, Jakobson says, with the general laws of irreversible solidarity (or unilateral implication) which govern the synchrony of all the languages of the world and determine their phonemic inventories. One of these

1.4. Symbols and Terms

All the symbols and terms are used with their usual values. The only questionable term is "Retroflexion." This name (like the others) is not meant to have physical phonetic reference. Not all r's are "retroflexed," in the strict sense. The term deretroflexion merely indicates a "loss of r-ness," leaving a purely vocalic sound.

2. Processes Found Affecting Liquids in the Children's Speech

2.1. Processes Directly Affecting Liquids

The main processes found to be operating directly on liquids involve a simple delateralization of l, and a "loss of r-ness" (or "deretroflexion") for r. The numbering used here is the numbering found in the list of processes in Appendix A. Delateralization is L3:

(L3) $\begin{bmatrix} -\text{coronal} \\ +\text{sonorant} \\ \pm\text{velar} \end{bmatrix} \rightarrow$ [-lateral]

i.e. a) $\begin{bmatrix} +\text{sonorant} \\ +\text{velar} \end{bmatrix} \rightarrow$ [-lateral]

$\underset{\frown}{u}^{l} \rightarrow \underset{\frown}{u}$

b) $\begin{bmatrix} +\text{sonorant} \\ -\text{velar} \end{bmatrix} \rightarrow$ [-lateral]

$\underset{\frown}{i}^{l} \rightarrow \underset{\frown}{i}$

Deretroflexion is R2:

(R2) Sonorant → -R

i.e. a) r → $\begin{bmatrix} -\text{coronal} \\ +\text{Rnd} \\ +\text{BK} \\ +\text{retro} \\ -\text{stress} \end{bmatrix}$ → $\underset{\frown}{o}$

b) r → $\begin{bmatrix} -\text{coronal} \\ -\text{Rnd} \\ +\text{BK} \\ +\text{retro} \\ -\text{stress} \end{bmatrix}$ → ə

c) $\acute{r}$ → $\begin{bmatrix} -\text{coronal} \\ +\text{Rnd} \\ +\text{BK} \\ +\text{retro} \\ +\text{stress} \end{bmatrix}$ → ó (more exactly $\acute{o}^{ə}$)

These processes result in a vocalic substitute whose syllabicity and quality depend on the syllabicity and vocalic quality of the underlying liquid. Since nonvelar l has basically an i-quality, its delateralized substitute would be a palatal, eventually y. However, l may be labiovelarized as in L1:

(L1) $l \rightarrow \begin{bmatrix} +\text{Rnd} \\ +\text{velar} \end{bmatrix}$

Its nonlateral substitute is a labiovelar or u-quality vowel. The contexts for (L1) vary, depending on the child, much as its degree of generality varies in English adult speech (see Appendix B). We do not expect the child's speech to reflect a more limited context for the process than does his adult model. In fact, we expect it at first to be less limited, if possible, and indeed this is the case with most of the children studied.

Since r has a ə-like quality, loss of its r-ness leaves a velar glide in most cases. However, as in adult idioms, r is labialized or rounded in certain contexts. R1 gives the process in its strongest form, with no contexts specified.

(R1) $\begin{bmatrix} r \\ \pm\text{syllabic} \end{bmatrix} \rightarrow [+\text{Rnd}]$

Therefore, upon deretroflexion, according to process R2, we get three distinct substitutes. For unstressed nonsyllabic r, we have nonsyllabic o or ə, depending on whether or not there is rounding, and for stressed syllabic $\overset{r}{w}$ we have syllabic ó. More precisely, we have a vowel with a nonround off-glide $\widetilde{o^{ə}_{\wedge}}$, because stressed syllabic r typically seems to end in a non-labialized r-glide. I have omitted this detail from the formulation of the processes, but it invites further study. Since American [r] is already [-coronal], there are only two (R) rules.

Process L2, Loss of Coronality, says that all l's become noncoronal (apical).

(L2) [+lateral] → [-coronal]

i.e. a) $\begin{bmatrix} l^{w} \\ +\text{velar} \\ +\text{Rnd} \end{bmatrix} \rightarrow u^{l}_{\wedge}$

b) $\begin{bmatrix} l \\ -\text{velar} \\ -\text{Rnd} \end{bmatrix} \rightarrow i^{l}_{\wedge}$

L3 is the important process of delateralization by which [-conronal] sonorants (especially [+round], [+velar]) become [-lateral].

2.2. Processes Indirectly Affecting Liquids

There are four other processes encountered in the children's speech which affected liquids indirectly, by applying to their substitutes. Process A raises $[o_{\wedge}]$ and $[o^{ə}_{\wedge}]$ resulting from R2 to $[u_{\wedge}]$ and $[u^{ə}_{\wedge}]$, respectively.

(A) Raising $\begin{bmatrix}\text{+vocalic}\\ \text{+Rnd}\end{bmatrix} \rightarrow$ [+High]

i.e. a) o → u

b) o͡ə → u͡ə

There do not seem to be any conditions for this rule. Perhaps it is "optional" or "morpheme-specific" but it does take place in most words, and it is similar to a process William Labov (1963) finds taking place in New York City dialects, where, e.g. [dɔ͡əg] 'dog' may become [du͡əg].

Process B, Glide Loss, says that the round glide [u̯] is lost. This handles the glides resulting from both l's and r's. The contexts vary, depending on the children.

(B) Glide Loss $\begin{bmatrix}\text{+round}\\ \text{glide}\end{bmatrix} \rightarrow \emptyset$

Process C, Strengthening, says simply that the glides i̯ and u̯ become y and w, respectively. The strongest form of the process says that this strengthening happens in syllable initial position (. indicates syllable boundary), after a syllable initial consonant, or between vowels.

(C) Strengthening glide → [-vocalic] / $\left\{\begin{matrix}.(C)\\ V\end{matrix}\right\}$ __ V a) b)

i.e. i̯ → y

u̯ → w

Process D is Absorption of nonsyllabic ə̯ by a preceding vowel.

(D) Absorption ə̯ → ∅ / [+vocalic] _

The processes, as discussed above, are in their strongest form. They will be limited and suppressed, and this will take place chronologically earlier in some positions than in others, and the particular order will be different with the different children.

For some of the children, additional processes are needed. These are special late processes which have very limited application. They are not general for all of the children. These are mentioned wherever they are needed to explain a substitution found in the speech of one of the children, and they are included in the summary in Appendix A.

The acquisition process is divided into stages, numbered by the year and the month. Forms are given for each stage. The variant forms which appear in the data result from the fact that children sometimes gave the same word several different ways on a single day.

There are also many cases of optionality. I am considering this as a "conditional" sort of limitation/suppression. Apparently some rules simply become optional, and we cannot state conditions saying exactly when they will apply.

3. Individual Case Studies

3.1. Daniel

The first child is Daniel, for whom I have data for the ages 1.6 to 3.1. At the first stage, all the major processes apply. Daniel labiovelarizes l's in all postsegmental contexts. The only l's excluded are initial ones. This is as it should be for him, since the only substitute ever found for initial l is y. In Daniel's parents' dialect it applies to l only in syllable offsets, but Daniel's older sister, Eve, had the process in its unlimited form and labiovelarized all l's.

$$\text{(L1)}\quad l \rightarrow \begin{bmatrix}+\text{Rnd}\\ +\text{velar}\end{bmatrix} \;/\; [\ ]\ \_$$

L2b, Loss of Coronality, is limited for Daniel as follows:

$$\text{(L2b)}\quad \begin{bmatrix}l\\ -\text{velar}\\ -\text{Rnd}\end{bmatrix} \rightarrow [-\text{coronal}] \;/\; \_\ \begin{bmatrix}\text{High}\\ \text{V}\end{bmatrix}$$

For the r's, there is labialization according to R1 in three environments. Daniel has the rule in the form:

$$\text{(R1)}\quad \text{a)}\ \begin{bmatrix}r\\ \pm\text{syll}\end{bmatrix} \rightarrow [+\text{Rnd}] \;/\; \left\{\begin{matrix}.C_0\_\\ +\text{stress}\\ \overline{V\_V}\end{matrix}\right\}$$

Part a) says that r's are labialized if they are syllable initial or follow one or more syllable initial consonants. Part b) says that r's are labialized when they are stressed, and part c) labialized intervocalic r's.

Process B, Glide Loss, has the following form for Daniel:

$$\text{(B)}\quad \begin{bmatrix}+\text{Rnd}\\ \text{Glide}\end{bmatrix} \rightarrow \phi \;/\; \left\{\begin{matrix}\text{V\_C} & \text{a)}\\ .\begin{bmatrix}\text{cor}\\ \text{cons}\end{bmatrix}\ \_\text{V} & \text{b)}\end{matrix}\right.$$

This says that the round glide [u̯] is lost (a) between a vowel and a consonant and (b) between a syllable initial noncoronal consonant and a vowel.

For Daniel Process D, ə̯-Absorption, occurs only after back vowels:

(D) $\underset{\wedge}{\text{ə}} \rightarrow \emptyset \; / \; \begin{bmatrix} +\text{voc} \\ +\text{Bk} \end{bmatrix} \_$

With all these processes applying, we get, at 1.6 and 1.7, for l's:

ball [bɑ́ʊ̯], milk [mʌ́k]
glasses [kɑkɑ]
lookie [yʊ́kiˌ], lion [laɪ̃]

For r's we find forms like:

rockie [wɑkiˌ], chair [tʰɪ́ə], car [kʰɑ́]
birdie [bʊ́jˌ], park [pʰɑ́kʰ], Mary [mɛ̃wiˌ]
grandma [gɛ̃məˌ], truck [tʷʌ́k]

At the next stage, 2.5, process B, part (a) is limited since milk is [mɛ́ʊ̯k], with a glide, but wolf is [wʊ́f]. The process is limited so that:

(B) $\begin{bmatrix} +\text{Rnd} \\ \text{glide} \end{bmatrix} \rightarrow \emptyset \; / \; \begin{bmatrix} +\text{High} \\ +\text{Bk} \\ \text{V} \end{bmatrix} \_$

This is a kind of absorption of [ʊ̯] by a preceding similar vowel. L2b is unchanged since:

Lizzie [yɪ́ziˌ], but lantern [laɪ̃ntən]

Process B, part (b), as limited above, is optional at this stage.

blue [bwʊ́], front [fwʌ̀nt], but
flowers [fɑ́ʊ̯əz]
glider [gɑ́ɹ̩dəˌ], bullfrog [bʊ́fɔg]

At this same stage (2.5), the main change with l's is that Delateralization (L3a) is limited in final position. We find circle, turtle, people, and ball with final [ʊ̯ˡ] from L2A, but seal is [sɪ́ʊ̯] without the lateral.

circle [sɟ́kəʊ̯ˡ], turtle [tʊ́ə̯dʊ̯ˡ]
people [pʰɪ́pəʊ̯ˡ], ball [bɔ́ʊ̯ˡ]
seal [sɪ́ʊ̯]

The word circle occurs at this stage with the correct stressed syllabic [r̩ʷ]. Since the rule for deretroflexion is still needed for several other forms of the same type, I am regarding this isolated word as an exception, or precursor of what is to come.

Process D, ə̯-Absorption, is limited here. The ə̯-glide is absorbed only after low back round vowels.

$$(D)\quad \overset{\frown}{ə} \rightarrow \emptyset \;/\; \begin{bmatrix} +\text{Low} \\ +\text{Bk} \\ +\text{Rnd} \\ \text{V} \end{bmatrix} -$$

birdie [bə́ (ə)di]
horsie [hóə̂si]

At the next stage, 2.6, process L2a, Loss of Coronality, has become optional, since we find l's occurring in:

blocks [bl^{w}ɔ́ks], flags [bl^{w}ǽgz], blue [bl^{w}ú]

but some other words have w's;

airplane [ǽphwe̯i̯n], play [phwé̯i̯]

and others have no trace of l or w:

clap [khǽp] clown [khǽu̯n]

The optionality of the process is shown clearly by the word plate, which occurs in the three possible forms:

[phé̯i̯t], [phwé̯i̯t], [phl^{w}é̯i̯t]

Rule B, Glide Loss, part (b), is optional, as it was at 2.5. This accounts for the forms for clap, clown, brush, brown, broke, and cream, some having w's and some having a zero substitute:

clap [khǽp], clown [khǽu̯n], brush [bʌ́s], brown [bǽu̯n]
broke [bwók], cream [kwím]

By stage 2.8, there have been a number of changes. Nearly all the processes concerning l's have been suppressed, and most l's are "normal," as in apple, flower, balloon, etc.

[hǽpl^{w}], [fəl^{w}ǽu̯r̥], [bəl^{w}ún]

More r's are appearing at this stage. R2, Deretroflexion (a and b) is limited, or better, optional, since limiting conditions are not evident. Room appears with an initial r, but red and Ringo still have w.

[rúm], [wɛ́d], [wíŋgo]

Crayons has a correct postconsonantal r. Teacher and picture have final r's, but together still has a final ə:

[thʃ́tsr̥], [phʃ́tsr̥], [thəgɛ́zə]

Process B, part (b) is optional here, as before, but the frequency of its application is decreasing.[1]

froggie [fɔ́gi], but bricks [bwɪ́ks], tree [twɪ́]

The only change at 2.10 is a limitation of Deretroflexion in intervocalic position, since pirates and fairy have correct r's.

[phɑ́ɪrɛts], [fɛ́ri]

At 2.11 a few vestiges of the l processes show up. For example, seal is found in two forms:

[sɪ́ɫ] ~ [sɪ́u̯]

R2, Deretroflexion (a and c) is optional in several positions. In initial position, we find r's in red and great (initial g is lost), but rabbit appears both with r and with w.

[rɛ́d], [rɛ́ɪt], [wɛ́bɪt] ~ [rɛ́bɪt]

For postconsonantal r's, correct r's are found in tree, three, green, and dragon, but w's are still found in try, string, and break. However, the r's here are actually intervocalic because Daniel inserts epenthetic ə's at this stage to break up clusters. Also, initial t's and st's before r's are realized as s's at this stage.

[sərɪ́], [gərɪ́n], [dərɛ́gn̩], [səwɑ́ɪ], [səwɪ́ŋ], [bəwɛ́ɪk]

In intervocalic position, orange and Mary have w's, but very has an r.

[ɔ́wɪnǰ], [mɛ́wi], but [vɛ́ri]

For preconsonantal r, the Deretroflexion process has finally become optional:

turtle [tʊ́əd̩] ~ [tɝ́d̩]

At the last stage, 3.1, there is no evidence of the processes affecting l's, and we find near-adult forms like little, wolf, blue, rolling:

[ɪfɪ́t̩ᵚ], [wʊ́ɫᵚf], [bɫᵚʊ́], [rɔ́u̯ɫᵚɪn]

However, the processes affecting r's are not yet entirely suppressed; part (a) of Deretroflexion, R2, is suppressed, since we find forms like:

[drɪ́ŋkt], [brɑ́u̯n], [ɔ́rɪnǰ], [gərɪ́ɫə]

As before, part (b) of R2 is optional in final position, and robber appears both with final r and with final ə:

[rɔ́bə] ~ [rɔ́bɹ̩]

Part (c) of R2 is optional. Turn and work have correct stressed [$\acute{r}_{w}$] but bird and worm have [u$\underset{\wedge}{ə}$], and turtle appears both ways:

[tʰɝ́n], [wɝ́k], [bʊ́ə̯d], [wʊ́ə̯m], [tʊ́ə̯dl̩] ~ [tɝ́dl̩]

Forms like these last are interesting, since they show an on-going process of suppression.

We see that by 3.1 Daniel has successfully suppressed or limited several of the innate processes, and is therefore much closer to the adult system.

3.2. Suzanne

The second child is Suzanne, for whom I have data from 2.10 to 3.1. From the beginning of this period she has correct initial and intervocalic l's. Therefore, she has already suppressed L2a, Loss of Coronality, in intervocalic position and L2b in initial position:

2.10 library [laɪ̯fɛrɪ], light [laɪ̯t], lion [laɪ̯n̩]
2.11 leaves [lɪ̯fs], living room [lɪ̯vɪvŋ]
3.0 lamb [lǽm]
3.1 lady [léɪ̯dɪ], learned [lɝ́nt]

L1, Labiovelarization, is limited for Suzie so that only postsegmental l's are labiovelarized.

$$(L1) \quad l \rightarrow \begin{bmatrix} +\text{Rnd} \\ +\text{Velar} \end{bmatrix} \quad / \; [\;\;] \_$$

L3a, Delateralization, is optional in final position at this stage, but L1 and L2a are needed for most of the forms.

$$(L3a) \quad \begin{bmatrix} \text{Son} \\ +\text{Velar} \end{bmatrix} \rightarrow [-\text{Lateral}] \; / \; \_\_ \; \# \qquad \text{optional}$$

bottle [bʌ́tɨ$\underset{\wedge}{(l)}$], people [pʰípəɨ$\underset{\wedge}{(l)}$], but apple [ǽpəɨ$\underset{\wedge}{l}$]
turtle [tʰɝ́tɨ$\underset{\wedge}{l}$]

Neither L2 nor L3 apply in the forms for candle, squirrel, or uncle.

[kʰǽn̩ʲʷ], [skwɝ́l̩ʲʷ], [ɔ́kʰl̩ʲʷ]

L2a, Loss of Coronality is also optional in postconsonantal position at 2.10; and B, Glide Loss, is limited.

(L2a) $\begin{bmatrix} l^{w} \\ +\text{velar} \\ +\text{Rnd} \end{bmatrix} \rightarrow [-\text{coronal}]^{l} \; / \left\{ \begin{matrix} C\_\_ \\ \_\_\ \# \end{matrix} \right\}$ optional

(B) $\begin{bmatrix} +\text{Rnd} \\ \text{Glide} \end{bmatrix} \rightarrow \phi \; / \; \begin{bmatrix} +\text{Hi} \\ +\text{Bk} \\ \text{V} \end{bmatrix} \_\_ \; C$

2.10 milk [mɪ̯ʊ̯k], glasses [gwǽsɨz], but floor [flóɹ̩]
2.11 told [tó͡ʊ̯d]

By 2.11 there is no evidence for L3a (Delateralization)in final position, and only one word shows the application of L2a (Loss of Coronality). Most final L's are normal.

owl [ǽ͡ʊ̯^{l}], but school [skú$^{l w}$]
dimple [dɪ́mp$^{l w}$], pill [pɪ́$^{l w}$]

L2a is also suppressed for postconsonantal l's.

2.11 plastic [p^{h}$^{l w}$ǽstɪk]
3.0 Santa Claus [sǽ̃nək$^{l w}$ɔz], flash [fl$^{l w}$ǽš]
3.1 slide [sl$^{l w}$á͡ɪ̯d], play [p^{h}l$^{l w}$é͡ɪ̯], clean [kl^{h}$^{l w}$ín̩t], etc.

By 3.0 and 3.1, L2 and L3 have been suppressed in final and preconsonantal position.

3.0 bottle [bɔ́d$^{l w}$], candle [k^{h}ǽ̃n$^{l w}$]
sail boat [sé$^{l w}$bo͡ʊ̯t], mail box [mé$^{l w}$bɔks],
spilled [səpɪ́$^{l w}$d]
3.1 school [skú$^{l w}$] or [skʊ́$^{l w}$], angel [ǽ̃nǰ$^{l w}$]
animal [ǽnm$^{l w}$], bottle [bɔ́t$^{l w}$] or [bɔ́d$^{l w}$]
spilled [spɪ́$^{l w}$dɨd], milk [mɛ́$^{l w}$k]

Vestiges of the processes show up in soldier at 3.1.

soldier [só͡ʊ̯ǰə]

Most r's are acquired by Suzie even at 2.10. R1, Labialization, is optional in initial position.

(R1) $\begin{bmatrix} r \\ \pm\text{syll} \end{bmatrix} \rightarrow [+\text{Rnd}] \; / \; \#\_\_$ optional

R2a, Deretroflexion, is optional in initial, intervocalic and postconsonantal positions.

(R2a) $\begin{bmatrix} r \\ w \end{bmatrix} \rightarrow \overset{o}{\wedge} \; / \left\{ \begin{matrix} \#\_\_ \\ V\_\_V \\ C\_\_ \end{matrix} \right\}$ optional

R2b is optional in preconsonantal and final positions.

(R2b) (r → / __ $\left\{\begin{matrix} C \\ \# \end{matrix}\right\}$) optional

and R2c is suppressed (stressed [ɹ́ʷ] is correct). A, Raising, and C, Strengthening, are operating; but B, Glide Loss, is optional in preconsonantal position.

(B) $\left[\begin{matrix} \text{glide} \\ \text{+Rnd} \end{matrix}\right]$ → ∅ / C__ optional

Initial: raisins [wéɪsə̃nz] ~ [réɪsə̃nz], rabbit [rǽbɪt]
Intervocalic: library [láɪfæri], carrot [kʰǽrət],
Postconsonantal: brings [bwɪ̃ŋz], but (eye) brows [bráʊs], brush [brʌ́s], giraffe [drǽf], hungry [hʌ́ŋgri]
Preconsonantal: years [ɹ́əz], but guitars [gɪtárz], party [pártɪ], girl [gɹ́ɪ], bird [bɹ́d], nursery [nɹ́sə̃ri], turtle [tɹ́tṵ], turkey [tɹ́ki], etc.
Final: floor [flór], alligator [ǽləgeɪtɹ], bear [béɪɹ], sister [stɪ́stɹ]

At 2.11 R2, Deretroflexion is almost entirely suppressed. R2a is suppressed in initial position, and R2c is suppressed in preconsonantal position. R2b is nearly suppressed in final position.

Initial: raisins [réɪsnz]
Final: sister [stɪ́stɹ]
Preconsonantal: university [junɪvɹ́sɪsti], purse [pɹ́s][2]
Postconsonantal: eyebrows [áɪbaʊ]
Intervocalic: Mary [mǽwi], Suzie Robinson [suzirɔ́bsn] kangaroos [kʰæŋərúz]

At 3.0 and 3.1, nearly all of the processes affecting r's are suppressed. R2a is suppressed in intervocalic position, although one word shows its operation in initial position. R2b is almost suppressed, but again a few words show its application in preconsonantal and final position. R2c is suppressed in postconsonantal and intervocalic position, and D, ə-Absorption, is suppressed.

Intervocalic: carrot [kʰǽrənthˀ], three [θərí], Mary [mǽri] tomorrow [tʰəmɔ́rn], ironing [áɪɹɪŋ]
Initial: read [wɪ́d] rabbit [rǽbɪt], rubber [rʌ́bə]
Preconsonantal: barn [bárn], airplane [ǽrpléɪn], airport [éɪporthˀ], reindeers [réɪndɪəz]
Final: pacifier [phˀǽsfaɪə], soldier [sóʊjə], bear [béɪə] pour [phˀóə], finger [fɪ́ŋɹ], sister [stɪ́stɹ]
Postconsonantal: aspirin [ǽsprɪn], camera [kʰǽmrə], Chris [kʰrɪ́st], frog [frɔ́g], angry [ǽŋgri], dress [dərɛˢ], bird [bɹ́d],[3] university [junɪvɹ́sti], learn [lɹ́nt]

3.3. Eleni

The third child is Eleni, for whom I have records for 2.1 to 2.8. Again, most substitutions are explicable within the framework already presented. In some cases this is not as clear as it might be because Eleni is behind the others in the acquisition process. Since she shortens words drastically, it is sometimes hard to tell exactly what processes are operating. For example balloon is [bú], presumably via

$$[bəlún] \rightarrow [blʷún] \rightarrow [bwún] \rightarrow [bún] \rightarrow [bú]$$

but we cannot be sure of this.

At the first stage, 2.1, there is evidence for most of the process. We have evidence later that initial l's are not labio-velarized. Therefore L1 has this limited form for Eleni:

$$\text{(L1)} \quad l \rightarrow \begin{bmatrix} +\text{Rnd} \\ +\text{velar} \end{bmatrix} \quad / \; [\;\;] \_$$

Initial y glides do not show up, but some u̯-glides appear in final and preconsonantal position. Therefore, B, Glide Loss, is limited somewhat.

$$\text{(B)} \quad \begin{bmatrix} \text{glide} \\ -\text{Rnd} \end{bmatrix} \rightarrow \phi \; / \; \# \_\_ V$$

$$\begin{bmatrix} \text{glide} \\ +\text{Rnd} \end{bmatrix} \rightarrow \phi \; / \; \left\{ \begin{matrix} (V\_\_\#) \\ .C\_\_V \end{matrix} \right\} \quad \text{optional}$$

Initial: lookie [ʊ̯ki]
Final:[4] ball [bóu̯] ~ [bʌ́], owl [áu̯], doll [dɔ́]
Preconsonantal: milk [mɐ́u̯k]
Postconsonantal: glasses [gæ̯·]

For r's, Labialization, R1, is limited for Eleni to:

$$\text{(R1)} \quad \begin{bmatrix} r \\ \pm\text{syll} \end{bmatrix} \rightarrow [+\text{Rnd}] \; / \; \left\{ \begin{matrix} .\text{Co}\_\_ \\ +\text{stress} \\ V\_\_V \end{matrix} \right\}$$

Process D, ə̯-Absorption, is also limited. It applies after low back vowels, but is optional after other vowels.

$$\text{(D)} \quad ə̯ \rightarrow \phi \; / \; \left\{ \begin{matrix} \begin{bmatrix} +\text{low} \\ +\text{Bk} \\ V \end{bmatrix} \_\_ \\ (V\_\_) \end{matrix} \right\} \quad \text{optional}$$

R2, Deretroflexion, applies in most words, but R2c is optional in preconsonantal position.

(R2c) $\begin{bmatrix} \acute{r} \\ w \end{bmatrix} \rightarrow o^{\vartheta}_{\wedge} \;/\; \_\_C$ optional

Final: car [ká], door [dóə] ~ [dɔ́]
Preconsonantal: horse [hɔ́s], marble [má?]
birdie [bú̟i̯], but dirty [dr̥]

At 2.2 the situation is nearly the same; L3a, Delateralization, is optional in preconsonantal position (see belt), and one word indicates that it is being suppressed in final position. (Ma)gill, the cat's name, appears a few times with the lateral. It is indicative of a later stage. Loss of initial y-glide (B above) is being suppressed.

Initial: look [ʌ́k] ~ [ʊ́k], lookie [ʊ́ki]
leaf [yí], lion [yái̯n], light [yái̯]
Final: ball [bɔ́u̯], Gill [gǽu̯] ~ [gɪ́u̯] ~ [gɪ́·u̯ˈ], turtle [tr̥u]
circle [sŕ̥gau̯], owl [áu̯], tail [té·u̯]
apple [ǽku], but girl [gú] ~ [gɔ́u̯], school [gú·]
doll [dɔ́]
Preconsonantal: belt [báu̯(l)?]
Postconsonantal: flowers [fáu̯ə(s)] ~ [fáu̯], clock [gák] ~ [kák], block [bák], glasses [dǽs], slide [dái̯]
plane [pé·] ~ [pé̟i̯n], flag [bǽk]
Intervocalic: balloon [bú(·)]

Concerning r's at this stage, Labialization, Deretroflexion, Raising, and Strengthening are needed to derive the forms with initial r's:.

rabbit [wǽbɪk] ~ [wǽbi], round [wáu̯], red [wɛ́ki]

The same processes are evident for postconsonantal r's, although B, Glide Loss, usually applies.

brush [bʌ́s], drum [dʌ́m], crayon [ké] ~ [gǽm], frog [fɔ́?]
train [té̟i̯n], pretty [pwɪ́ti]

The form for pretty indicates that Glide Loss is beginning to be limited. However, since process B is still needed for most forms until 2.8, this may be just an exceptional word, far ahead of its time.

For words with final r's, Deretroflexion and ə-Absorption apply.

door [dó] ~ [dʊ́], guitar [gɪtá], car [ká] ~ [kʌ́]
star [tɑ̌]
sugar [šʊ́kə], picture [pítə]

The situation with preconsonantal r's is nearly the same as at the previous stage, except that R2c, Deretroflexion, is even more limited, since more cases of [ɚ̃ʷ] appear, and a few forms indicate that A, Raising, is optional.

horse [(h)ɔ̝̈ə̝̈s̆] ~ [(h)ó̝̈ə̝̈s̆] ~ [ɔ́s̆] ~ [ʊ́s̆]
card [gá·], George [dʒɔ́]
church [cɚ̃?], turtle [tɚ̃u], circle [sɚ̃gaɥ]
Bird [bɚ̃] ~ [bú̝̈ə̝̈] ~ [bú], girl [gú] ~ [gʊ̈ɥ], turkey[tʊ́ki]

Only one word, orange, is found which should have an intervocalic r. This appears as [ɔ́ə̝̈?] in Eleni's speech, and it could indicate that Eleni does not labialize intervocalic r's, since Deretroflexion alone would give [ə̝̈], or the [ə̝̈] could be a normal off-glide of [o]. This cannot be checked because there are no other comparable forms.

The major changes for l's at 2.4 are that L2a, Loss of Coronality is being limited in final position, and is nearly suppressed in intervocalic position, and L3a, Delateralization (of velar sonorants) is being suppressed in final position.

Initial: lion [yã̝̈i̯], look [ʊ́k]
Final: owl [áɥ], Gill [gɪ̈ɥ], circle [sɚ̃kaɥ], ball [bɔ́ɥ], school [gʊ́ɥ], and animal [gæ̃mɨ], girl [gɪ̈ɥ] ~ [gɚ̃ʷ]
Postconsonantal: clock [kʰákʰ], flower [fáɥ], airplane [æ̃peɨn]
Intervocalic: umbrella [bʌ́lə], impala [pálə]

For r's at 2.4, R2c (Deretroflexion of [ɚ̃ʷ]) is suppressed in preconsonantal position. One word, some more, occurs as an exception to R2b, and two words occur as exceptions to R2a in postconsonantal position. Otherwise, the situation has not changed since 2.2.

Initial: read [wíd]
Final: guitar [tʰá], car [gá] ~ [ká], zipper [zɪ́pə]
bear [béə], tiger [tá̝̈gə], deer [dɪ́ə], paper [bé̝̈pə]
upstairs [əpəstéjə], but some more [əmɔ́r]
Preconsonantal: yarn [ná·n], airplane [æ̃peɨn], horse [ɔ́s̆]
girl [gɚ̃], turkey [tɚ̃ki], my turn [mä̝tʰɚ̃]
Postconsonantal: zebras [zíbrə], throw away [froɥ̈wé̝̈]

At 2.6 there have been a few changes. For initial l's, the Glide Loss rule

$$\begin{bmatrix}\text{glide}\\ -\text{Rnd}\end{bmatrix} \rightarrow \emptyset \;/\; \#\_\_$$

has been suppressed.

light [yáɪ̯t]

For final l's, some words indicate that L1, L2, L3 and loss of w-glide are still in operation.

animal [ǽm ə], apple [ʔǽpə], turtle [dɔ́də] ~ [dɔ́ə̯də]
doll [dɔ́], snail [sné·i̯]

But, two words show that Glide Loss is partially suppressed.

Gill [gǽu̯], girl [gíu̯]

And one word, owl, shows a limitation of Delateralization (L3) in final position.

owl [áu̯ˡ]

Two words show that L2a, Loss of Coronality, is being limited in final position.

doll [dɔ́ˡʷ], ball [bɔ́ˡʷ]

L2a is also limited or optional in intervocalic position.

balloon [bəún], but umbrella [ədəbʌ́ˡʌ]

The other forms show no changes:

milk [mɔ́k]
airplane [ǽrpeɪ̯n], flower [fáuə], sleepy [sípi],
block [bák]
floor [fɔ́·ə], clock [gʌ́k]

By 2.5, R2b, Deretroflexion of r, has become optional in final position and preconsonantal position. The other forms show no change from 2.4.

Final: upstairs [əpəstéɪ̯r] ~ [əpəstéɪ̯ə], but chair [séɪ̯ə]
piece of paper [bɪsəbéɪ̯bə], somemore [əmɔ́ə],
there [déɪ̯ə]
Preconsonantal: Marsha [mášə], horsie [ɔ́ə̯si] ~ [ʌ́si] ~ [ɔ́š]
birdie [búə̯di] ~ [búdi], airplane [ǽ(r)peɪ̯n]
my turn [maɪ̯tn̩]
Postconsonantal: brush [bʌ́s] ~ [bʌ́š], truck [ǰʌ́k]
ice cream [áɪ̯skim], throw away [fowéɪ̯]
train [čéɪ̯n] ~ [zéɪ̯n], dress [dɛ́s]

At 2.8, the last stage for which I have data, the main changes for l are the suppression of L2b, Loss of Coronality, in initial position, and the optionality of L2a in preconsonantal position.[6]

Initial:[7] look [lʌ́k]
Final: table [dé̞jbəlʷ], but apple [ápu·], Gill [gɪ́ɻ̩]
pencil [bɛ̂nsu], cereal [sɪ́·u], cradle [ké̞jdaɻ̩],
hill [ɪ́ú], Jill [zɪ́ɻ̩], circle [sɹ̍́kəɻ̩] ~ [sɹ̍́kə],
school [skúə], ball [bú·ə], rattle [wǽ̌də]
Preconsonantal: animals [ǽməlʷz], but milk [mɑ́ɻ̩k]
hold this [hóɻ̩ǰɪs]
Postconsonantal: blue [bú·], flower [fɑ́ɻ̩ə], floor [fúə]
sleepy [slɪ́pi], playing [bé̞j]

At 2.8, R2a, Deretroflexion, has become optional in initial position, and the other processes remain as at 2.6.

Initial: (a)round [wɑ́ɻ̩n], rattle [wǽ̌də], but read [rɪ́d]
record [wɛ́kə] ~ [rɛ́kə]
Final: deer [dɪ́ə] ~ [dɪ́ɹ̩], bear [bé̞jə], tiger [dɑ́jgə]
flower [fáu(ə)], supper [sʌ́pə], here [hɪ́·ə]
ear [ɪ́ə], color [kʌ́̌də], upstairs [əp(ə)sté̞jə]
Preconsonantal: Marsha [mɔ́̌sə] ~ [mɑ́̌sə], horsie [hɑ́̌sɪ]
circle [sɹ̍́kə] ~ [sɹ̍́kəɻ̩]
Postconsonantal: frog [fɔ́k], tree [fɪ́], ice cream [ʌ́skim]
cradle [ké̞ldaɻ̩], drinking [dɪ́ŋkɪŋ],
broke [bɔ́k], green [gɪ́ən]

It appears that, although Eleni is behind the other children in her acquisition of liquids, the same general processes are evident in her progress.

3.4. Melissa

The fourth child is Melissa. She was slightly older when I observed her (3.1 to 4.1), but the substitutions found in her speech for l and r are derivable by the same processes. L's are nearly correct: L2a, Loss of Coronality, has been suppressed.

Final: squirrel [wɪ́rəlʷ], beautiful [bú̞fəlʷ],
ball [bɔ́lʷ]
Postconsonantal: Kluge [klʷúgi], chocolate [ʃ̌lʷɔ́klɪt] (3.1)
[ʧ̌ɔ́klʷɪt] (3.7)
Intervocalic: yellow [dʒɛ́lʷo] at 3.4, coloring
[kʰʌ́lʷrɪn], at 3.7.

At the earliest stage, intervocalic l's are very tenuous. It appears for all these children that at early stages, intervocalic l's are subject to assimilation or some other modification. For example:

Molly [mɔ́ni], vanilla [nɪ́nə], Sally [sǽdi]
dolly [dɔ́di]

For r's Melissa labializes r's as shown below:

$$(R1)\quad \begin{bmatrix} r \\ \pm syll \end{bmatrix} \rightarrow [+Rnd] \;/\; \left\{ \begin{matrix} .Co\_\_\_ \\ +stress \\ \overline{V\_\_V} \end{matrix} \right\}$$

However, she has nearly suppressed R2, Deretroflexion. R2a is suppressed in intervocalic position, although it shows up somewhat in postconsonantal position. R2c applies infrequently in preconsonantal position. Processes R1, R2a, Aa, and C account for forms like:

write [wáɹ̥t] at 3.7
brush [bwʌ̊s] at 3.1

Loss of the glide (Process B) is shown in just one word:

ice cream [á̠ɹ̥sfim] at 3.7

The other words show that R2a is nearly suppressed in post-consonantal position from 3.4 on.

3.4: thread [tɹɛ́d], Cricket [fɹíkɪt], Chris [fɹís]
3.7: crib [tɹíb], grandpa [dɹǽmpə], throw [fɹó̠ʊ̯] ~ [fwó̠ʊ̯], tree [fɹí]
4.1: ice cream [á̠ɹ̥stɹim], Gretchen [dɹɛ́c̆ɪn], across [ətɹɔ́s]
Intervocalic: squirrel [wíɹəl] at 3.1

R2b is needed for most final r's at these stages. D, ə̠-Absorption is limited so that

$$ə̠ \rightarrow \emptyset \;/\; \begin{bmatrix} +voc \\ +back \end{bmatrix} \_\_$$

3.1: there [nɛ́ɹ̥ə]
3.4: sweater [tw̥ɛ́tə]
3.7: bother [bɔ́ðə], remember [mɛ́mbə], picture [pʰíc̆ə]
4.1: Christopher [tɹístəfə]

R2b and ə̠-Absorption account for apart at 3.7.[8]

apart [pʰá·t]

R2c is nearly suppressed in preconsonantal position.

3.1: jersey [dɹ̥ɹ̥zi]
3.7: disturb [stɹ̥̆b], jersey [dʒɹ̥̆zi]

3.5. Jennifer

I have a few notes from David Stampe about his niece Jennifer's acquisition of liquids at one stage, 2.0. The forms found at

this time can all be explained by the basic processes we have been using. Jennifer labiovelarizes l's in post-segmental positions.

(L1) $$l \rightarrow \begin{bmatrix} +\text{Rnd} \\ +\text{velar} \end{bmatrix} \; / \; [\;] \_$$

Lb2, Loss of Coronality, is suppressed entirely, and L2a is limited.

(L2a) $$\begin{bmatrix} +\text{velar} \\ +\text{Rnd} \end{bmatrix}^{l^w} \rightarrow \hat{u}^{l} \; / \; \left\{ \begin{array}{l} f\_\_V \\ \_\_ \left\{ \begin{matrix} C \\ \# \end{matrix} \right\} \end{array} \right\}$$

Delateralization, L3, is in its normal form. B, Glide Loss, is limited to round glides in specific environments.

(B) $$\begin{bmatrix} +\text{Rnd} \\ \text{glide} \end{bmatrix} \rightarrow \emptyset \; / \; \left\{ \begin{array}{l} V\_\_ \left\{ \begin{matrix} \# \\ (C) \end{matrix} \right\} \\ C\_\_V \end{array} \right\}$$

These processes give the forms below:

Initial: look [lʷúk], lotta [lá] (via [lárə])
Final: ball [bɔ́·], tickle [tɨ́ku]
Preconsonantal: help [hɛ́p], animals [ǽmoz][9]
Postconsonantal: play [pleʷe·], blue [bleʷu·]
fly [fáɹ̥], flag [fǽɹ̥d][10]

For r's, Jennifer labializes r's as follows:

(R1) $$\begin{bmatrix} r \\ \pm\text{syll} \end{bmatrix} \rightarrow [+\text{Rnd}] \; / \; \left\{ \begin{array}{l} .C\_\_\_ \\ +\text{stress} \end{array} \right\}$$

Since no words occur with intervocalic r, we cannot tell if this should be included in the environment. R2, Deretroflexion, is taking place, and there is evidence for A, Raising, and B, Glide Loss, as given for l's. Strengthening (C) and ə-Absorption are also in operation. These give the forms:

Initial: red [wɛ́·d]
Final: other [ʌ́zə], water [wɑ́tə]
Preconsonantal: bird [bʊ́·d]
Postconsonantal: frog [fɔ́·d], tree [tɪ́·][11]

3.6. Emily

I have data for Emily Salus only at 1.7. It is interesting, however, because Emily consistently substitutes n for light l.

For her, L1, Labiovelarization, is limited and does not include intervocalic l's. She evidently has some late process by which light l's become n's.

(b) $\begin{bmatrix} l \\ -\text{Rnd} \\ -\text{velar} \end{bmatrix} \rightarrow n$

This substitution is not due to assimilation, since we find such forms as [ni] for Lee. It will be seen in Appendix B that the interchange of l and n is not an uncommon process. The other substitutions are easily accounted for by the processes as we have given them. The substitute for final l is w (presumably u in our transcription). This could be accounted for by L1, L2a, and L3a. Preconsonantal and postconsonantal l's have zero as the substitute. This can be explained by Labiovelarization (L1), Loss of Coronality (L2a), Delateralization (L3a), and Glide Loss (B).

4. Reanalysis of Studies from the Literature

4.1. Joan Velten

Joan Velten's progress is reported in her father's article (Velten 1943). Our same basic processes account for most of Joan's substitutions, but a few minor additions must be made. At every stage during the period (1.10 to 3.6), [z] is substituted regularly for initial l, and no word ever occurs with a correct initial l. Moreover, in a few words [z] is substituted for intervocalic l. If Joan has a limited form of Labiovelarization, excluding initial l's and some intervocalic l's, we can say simply that she has process L2b (Loss of Coronality), L3b (Delateralization) and C(Strengthening), but has an additional late process by which y's become z's.[12] So we just need to add an additional minor rule for Joan, ordered after Process C; and B, Glide Loss must be limited to exclude [-round] glides. Thus

(a) $y \rightarrow (\check{z}) \rightarrow z$

This gives the correct forms.

Initial:	1.10:	light [zat], leaf [zuf], laugh [zaf]
	1.11-2.8:	lunch [zats][13] lion [zad], liver [zua], lap [zap], long [za·d], lake [zu·t], etc.
	2.6-2.9:	license plate [zasɪns pu·t]
	2.9-3.0:	love [zav]
Intervocalic:	1.10:	color [daz], Napolean [buz]

At the first stage, 1.10, L1, L2a, L3a, and B, Glide Loss, give the correct forms, except that Glide Loss is limited.

(B) $\begin{bmatrix} \text{glide} \\ +\text{Rnd} \end{bmatrix} \rightarrow \phi \; / \; \left\{ \begin{matrix} V \_\_ \begin{Bmatrix} \# \\ C \end{Bmatrix} \\ .C \_\_ V \end{matrix} \right\}$

Final: fall [fu], sole [zu], wall [wu], hole [hu]
ball, bowl [bu], nail [nu], table [du bu]
noodle [nudu]
Preconsonantal: milk [mut], help [hup]
fly [fa], flap [fap], glass [das],
flower [fawa], block, black [bat],
blow, blue [bu]

At the next stage, 1.11 to 2.3, the major change with l's is the limitation of Process B, Glide Loss, in final and preconsonantal positions. Round glides are always lost after an u vowel, and are optionally lost after other vowels:

(B) $\begin{bmatrix} \text{Glide} \\ +\text{Rnd} \end{bmatrix} \rightarrow \phi \; / \; \left\{ \begin{matrix} u- \\ \left(V - \begin{Bmatrix} C \\ \# \end{Bmatrix} \right) \end{matrix} \right\}$ optional

Final: all [a], doll [da], call [ta], ball [bu],
fall [fu], wall [wu], while [fa], pail, spill
peal, pole, pearl, pull, pool, spoil [pu]
well [waw],[14] smell [maw], bell [baw]
shell, shall [saw], gull [daw], owl [aw]
bubble [babu], people, purple [pu·bu]
Preconsonantal: wolf [wuf]
called [ta·d], cold [tu·d][15]
belt [bawt]
Postconsonantal: fly [fa], plumber [babu], plants [pats]
blocks [bats], clean [tu·d], slide [sa·d]
Intervocalic: belong [buza·d]
jelly [dawa], yellow [zawa], gallant [dawat]
Wallace [wawas]
pillow, peeler, pulling [pua]

At the last stage (through 3.0) there are no major changes.

Initial: love [zav]
Final: tell [taw], cocktail [ta·p-tu], uncle [antu]
Preconsonantal: child [ta·d], cold [tu·d]
Postconsonantal: clock [ta·t], cloth [ta·s],
airplane [u·-pu·d], plate [pu·t],
gloomy [du·mɪ], fly [faɪ]
Intervocalic: color [taz], telephone [tawafud]

The processes as I have formualted them account for most of Joan's substitutions for r's. Only a few minor additions must be made. For Joan, most r's are labialized except some in word final

position. Labialization is optional in final position. Those final r's which are not labialized show up as [a] instead of [ə] if the ɹ is not absorbed. Since Joan has no ə's in her inventory of sounds at these stages, she apparently has a late process.

(d) ə → a

This follows D, ə-Absorption (ə → ∅ / [+vocalic] _) which applies in all words except liver which is ahead of its time.

1.10: Initial: rose [wus], rough [waf], rabbit [wabut], room [wub], rain [wud], rock [wat], roof [wuf]
Final: bear [bu:], star [da], more [mu], ear [u], bear, bare, pare [bu], near [nu] sugar [zudu] liver [zua], tower, cover [dawa], flower [fawa], hammer [hama]
Preconsonantal: horse [us] > [hus], arm [am], bark [bat], board [but] nurse [nus], bird [but]
Postconsonantal: grandpa [daba] > [dap], broom [bub], train [dud], bread [but], drip [dup], dress [dus], brush [bas], brick, break [but][16]
Intervocalic: (to)morrow [maz] > [maza], Harry [haz] > [haza]

The substitution of [z] for intervocalic [r] at this stage is not accounted for by our processes. The expected substitute would be w which is the normal substitute at later stages. These r's are apparently not labialized. Then Joan may have another late process by which nonvelar r's become y. See Appendix A, R1 and R2d. Then the y would become [z], by the process given earlier.[17] (Appendix B has examples of the change of [r] to [z]).

At the next stage, 1.11 to 2.3, the situation is substantially the same. Glide Loss, B, is limited as it was for l's, and intervocalic r's are now labialized and become w's, if not lost.

Initial: right [wat], rubber [wabu], ring [wud], reach [wuts], red [wu·t] > [wud], rib, rim [wub], rouge [wu·z]
Final: far [fa], door [du] letter [zazu], paper [pu·bu], ladder [za·du] fire [faza], better [baza], grocer [du·sa]
Preconsonantal: morning [munu], dark [dat], yard [za·d] cord [tu·d], garbage [da·budz] pearl [pu], birdie [bu·du], hurt [hu·t] turn [tu·d], purple [pu·bu]

Postconsonantal: bread [but], broken [bu·du], grease [du·s], train [tu·d], green [du·d], probably [pabu] grocer [du·sa]
Intervocalic: sorry [sawa], Mary, marry [mawa], carry, cherry [dawa], paring, pouring, purring [pua], mirror [mua] worry [wua]

The rules as they are at the previous stage also account for most of the forms found at the last stage (2.6 to 3.0). Some final syllabic r's are still labialized and some are not, giving [u] and [a], respectively. Most of the processes are still operating, so that no trace is left of postconsonantal r or preconsonantal r (except for occasional lengthening of the preceding vowel). B, Glide Loss, is further limited so that the glide is not lost after vowels (see cigarette below).

Initial: red [wɪ·d], reader [wɪ·du]
Final: airplane [u·-pu·d], vinegar [vɪndu], reader [wɪ·du], farmer [fa·ma]
Preconsonantal: scarf [ta·f], tart [ta·t], stars cars [ta·z], davenport [dawaput], farmer [fa·ma], turn [tu·d]
Postconsonantal: crush [das], cross [ta·s], cream [tu·b], apricots [u·putats], cross-the-street [tasatu·t], apron [u·pɪn]
Intervocalic: cigarette [suduwɪt]

4.2. Hildegard Leopold

Hildegrad Leopold's acquisition of liquids is interesting for a number of reasons. First, her father kept a very complete record of her speech (Leopold 1947), and second, since she learned both German and English, we can compare her treatment of liquids in the two languages.

About the liquids, Leopold (1947:116) says that r and R were not "learned" during the first two years by Hildegrad, and l was not regularly articulated in the correct way. He also notes that English l and German l are treated differently because they differ in manner of production, the German l being articulated with a "flatter tongue" than the English, which is often accompanied by more or less "raising of the back (of the) tongue" (Leopold 1947:64).

Most of Hildegard's substitutions can be accounted for by the processes we have formulated. She does not labiovelarize as many l's, probably because of the influences of the German "clear" l. Her vocalic substitutes also show less uniformity, but we can account for this by late vowel changing rules.

English and German initial l's are treated similarly by Hildegard. Usually they are replaced by h or j(y), j being favored at the end of the period.[18] Initial l is correct in the last two months. Leopold says that j is easily understood as a substitute for l. The complicated continuant features are initiated incorrectly by the production of an easier neighboring continuant. Leopold interprets h as a form of omission, the presence of an initial consonant being vaguely indicated by the unchecked breath stream. See Appendix B for Grammont's explanation of the similarity of l and h. Gaberell Drachman (personal communication) has suggested a physiological explanation for this. He says that the tongue intrinsic horizontal muscle is not yet under control. So an l produced with a lowered tongue tip may be realized as h or z depending on the degree of approximation of the lowered tongue tip. This process would, then, also explain the l → (y) → z process found in the data for Joan Velten.

$$l \xrightarrow{L2,\ L3} y \rightarrow (\check{z}) \rightarrow \begin{Bmatrix} z \\ h \end{Bmatrix}$$

Then we can say that the h substitute is due simply to this late process accounted for by lack of tongue tip control. As this control is acquired, the process is suppressed, and j (or y, in our notation) is the substitute, explicable by Loss of Coronality, Delateralization, and Strengthening. (Glide Loss is limited and does not apply to most initial glides).

Initial: light [haɪ] ~ [aɪ] at 1.6, 1.8, 1.10, 1.11
look [hek] at 2.1
lie [jaɪ] at 1.11
like [jaɪ] at 2.1

For German words:

lutscht [juʃ], loch [jokˊ] ~ [lokˊ] at 1.10
Löscher [jokɛ] ~ [loka] at 1.11

The situation with final l's is more complicated. German and English final l's are treated differently. In many words final nonsyllabic l is omitted. This can be accounted for by processes L1, L2, L3, and Absorption of the glide. The substitute for English velarized l is often [ʊ], whereas [ɪ] is often found for German l.[20]

The contrast between German and English l shows up in ball:

Ball [baɪ] > [ba] at 1.5-1.8
ball [baʊ] at 1.9

The forms for rollen and roll suggest that the German and English words are in competition; the stressed vowels and palatals

point to German, while the [u] probably developed from English velar l.

[wɔ] ~ [wɔə] at 1.8
[wɔ:] ~ [wɔ:ɪ] ~ [wə|u] at 1.9
[wɔ] ~ [wo] at 1.11
[wo] at 2.1

Later [ə] is found for both [ɪ] and [ʊ]. In English this is often lowered to [a] or an intermediate vowel. This was regular in English after high front vowels. It was lowered after back vowels also in German, but not lastingly. Hildegard seems to have late processes whereby vowels are lowered or otherwise changed. This accounts for the variety of vowels.

(c2) $\left\{\begin{matrix}\text{I}\\\text{U}\end{matrix}\right\}$ → ə → a optional

A final l is achieved only in oil:

[ʔɔɪ] at 1.6
[ʔɔɪə] ~ [ʔɔɪ|ə] at 1.7

Final syllabic l's are not completely lost, but show up as a variety of vowels, in accordance with the above vowel changing process. Most nonsyllabic final l's are lost entirely at early stages. L1, Labiovelarization, is optional for final l's. L2, Loss of Coronality, and L3, Delaterization, are operating. Then B, Glide Loss, limited as below, gives zero as the substitute for final labiovelarized nonsyllabic l.

(B) $\left[\begin{matrix}\text{glide}\\+\text{Rnd}\end{matrix}\right]$ → ∅ / $\left\{\begin{matrix}\text{C}\\\text{V}\end{matrix}\right\}$ —

At 1.8 this process is further limited (see all wet), and more final glides appear. From 1.8 on Glide Loss is optional after [a] and most other vowels. Glides are always lost after [ɔ] and [o].

(B) $\left[\begin{matrix}\text{glide}\\+\text{Rnd}\end{matrix}\right]$ → ∅ / $\left(\begin{matrix}\text{C}\ \text{—}\\\left\{\begin{matrix}\text{ɔ}\\\text{o}\end{matrix}\right\}\ \text{—}\\\left(\left\{\begin{matrix}\text{a}\\\text{V}\end{matrix}\right\}\ \text{—}\right)\end{matrix}\right)$ optional

The glides which are not lost are often changed (especially after high vowels) by the above vowel changing rule. The form for towel at 1.10 shows that L2, Loss of Coronality, is optional in at least this one word.

The following English forms are found with final l in the model:[21]

1.5: all [ʔa:]
apple [ʔapa] > [aba]
1.6: oil [ʔɔɪ]
bottle [ba|u] ~ [ba:ɪ]
1.7: oil [ʔɔɪə] ~ [ʔɔɪ|ə], all [ʔa:]
bottle [ba·ɪ]
1.8: Paul [ba], all (wet) [ʔa] ~ [aʷwe]
wheel [wɪ·] ~ [wɔə]
apple [ʔapa], bottle [baɪu]
1.9: oil [ʔɔɪɔ], ball [baʊ], roll [wɔ:] ~ [wɔ:ɪ] ~ [wɔju] ~ [wɔ|u]
bottle [ba|u] ~ [baju]
1.10: oil [ʔɔɪ|o], all [ʔa] ~ [ʔa]
wheel [wi|]
bottle [ba|u], measles [mia], towel [daʊ(ɪ)]
1.11: fall [wɔ], roll [wɔ] ~ [wo], call [da] ~ [dɔ] [kɔ]
all [ʔaʊ] ~ [ʔa], ball, bell [baʊ], spill [bia]
bottle [ba|u], nail(s) [nea], pail [bea],
wheel [wiə] ~ [wia], towel [daʊ],
automobile [ʔatobiə]
2.0: all [ʔɔ:], fall [wɔ] ~ [fɔ] ~ [waʊ]
nail [nea]
2.1: ringbell [wibɔ], all [ɔ:], roll [wo], hole [ho]
automobile [ʔaʊto,biə]

For German final l's, processes L2 and L3 plus late vowel-changing processes give the following forms:

1.3: Ball [ba:ɪ]
1.8: dunkel [dʊdʊ] ~ [dɔdɔ]
1.9: dunkel [dɔkɔ]
1.10: dunkel [duko] ~ [dukɔ]
1.11: Nägel [nea]

There are few words with preconsonantal l. The most common is milk. It occurs with a [ə], which could possibly represent the German palatal or English velar l. It can be accounted for by the vowel-changing rule given above. In the other words the vocalic substitute is absorbed. Therefore process B, Glide Loss; as given earlier, is operating. Process D, ə-Absorption is optional here, since some ə's do appear.

1.6: milk [mɪ·]
1.7: milk [mɪə] > [mɪ]
1.9: milk [mea]
1.10 and 1.11: milk [mɪk][22]
cold [do] ~ [doi]
1.11: wheelbarrow [wibaʊ]

Postconsonantal l's are generally unrepresented (in German and English alike). We can account for most of the forms by

saying that Labiovelarization, Loss of Coronality, Delateralization, and Glide Loss apply.

block [bak̚] ~ [ba], please [bi], blow [bo] < [baʊ̯ˣ]
glass [das], airplane [ʔɛɪpi]

However, three words appear with initial w and one with initial j:

flower [waʊ̯] at 1.7 and 1.11
Florence [wos̬], fly [wa ɪ] at 1.11
slide [jaɪ] at 1.11

The occurrence of the w's could mean that B, Glide Loss, is being limited, but Leopold says that the w's are from the f's in these words (1947:67). Likewise we cannot be sure whether the j in slide results from an unlabiovelarized l or from s.[23]

Hildegard treats intervocalic l's differently, depending on whether the model is German or English. German intervocalic l's are never completely omitted. They occur as imperfect l, English velar l, j or correct l. The most frequent substitute is j because German intervocalic l's are not labiovelarized. Correct l's occur more often in the last two months. English intervocalic l, on the other hand, is usually omitted as late as 1.11. Leopold (1947:115) says that its omission may be connected with the standard raising of the back of the tongue. The front fricative is a less satisfactory substitute for it. Hello is found with a strongly velarized l from 1.5 on (a precursor of later events), but Helen has a j, indicating lack of labiovelarization. In the other cases L1, L2, L3 and Process B, Glide Loss, account for the forms. For postconsonantal and intervocalic l's, Glide Loss must be modified from the form given for final glides to include:

(B) $$\begin{bmatrix} \text{glide} \\ +\text{Rnd} \end{bmatrix} \rightarrow \phi \; / \; \begin{Bmatrix} C \\ V \end{Bmatrix} \; \_\_ \; V$$

1.5: hello [ʔəlɔ]
1.6-1.11: dolly [da:i] ~ [da(·)ɪ]
1.9, 1.10, 2.0: Helen [haja]
1.10: balloon [bu:]
1.11: alley [ʔa·i], Alex [ʔa·i], pillow [bɪə] ~ [bia]
hello [joj], Mary Alice [mea'ʔa] ~ [me'ʔa] ~ [mɛ'ʔaʊ̯]

Hildegard did not produce an r during the first two years. She either substituted something for it or omitted it. Leopold says (1947:164) that the chief characteristic of r is a moderately raised position of the tongue tip requiring complicated adjustment of the tongue muscles, difficult for children. Adding to the complication in this case is the fact that German uvular R is so different from English r. It is a velar spirant or roll or even a velar fricative, but it is functionally

closely parallel to English r, and Hildegard treats them in much the same way.

The processes work out quite well for Hildegard's treatment of r. Initial r is replaced by [w] consistently, as we would expect. Leopold (1947:114) says that raising of the back of the tongue, essential for R is also registered as accompanying the articulation of [r]. The sound is thus akin to [u]. Before a vowel, this becomes the glide [w].

A few words do appear early with [h] or [j] for initial r. Leopold would explain the [h] as breath denoting the presence of some consonant. See Appendix B for processes changing [r] to [h]. Leopold (1947:114) says that [j] is an "unsuccessful rendering of the front part of r." Both of these early substitutes could be explained by the lack of muscular control, as for the l's at an early stage. The [w] substitutes in the other words are regularly derivable by Labialization, Deretroflexion, Raising, and Strengthening.

1.8, 1.10, 1.11, 2.1: ride [haɪ]
1.11, 2.0: room [hu]
1.11: write [jaɪ]
1.5: Rita [wiwi]
1.8: roll [wɔə], rock-a-bye-baby [wawa], allright [ʔawaɪ]
1.9: roll [wɔ:] ~ [wɔ:ɪ] ~ [wɔju] ~ [wɔ|u]
1.10: radio [wea], rock-a-bye [wɔk, bebi], allright [ʔa'waɪ],
1.11: rock-a-bye-baby [wɔkə'bebi], roll [wɔ] ~ [wɔ], read [wi(ə)], ring bell [wɪbaʊ], right there [waɪt´(da)], a lright [ʔa'waɪ], Rita [wiwi]
2.1: ring bell [wibɔ]

With final r's, as with final l's, there is less uniformity. The vowel substitutes are of varying quality. Leopold reports that his final [R] has the North German colloquial pronunciation and is slurred to [ə] or is omitted, and after [a] is practically inaudible. So we are not surprised to find the nearly standard form of mehr [mea] at 1.5, and weisser [waɪsə] for Hildegard at 1.9.

Final r's are not labialized in Hildegard's speech. R1 has the following form.

$$(R1) \qquad \begin{bmatrix} r \\ \pm syll \end{bmatrix} \rightarrow [+Rnd] \quad \left\{ \begin{matrix} .Co\_\_ \\ +stress \\ V\_\_V \end{matrix} \right\}$$

Then processes R2 (Deretroflexion) and D (ə-Absorption) account for most of the forms with final r's if we add to them some late minor rules to change [ə] to other vowels, ([i, ɪ, a] etc.) when it is not absorbed.[24] There do not appear to be any conditioning factors for these vowel changes.

0.10-1.4: there [dɛ(:)] ~ [dɪ:] ~ [dəi] ~ [da:]
1.5: high chair [aɪta], there [ʔə]
1.6: more [mɔ], there [da]
1.7: water [wa·] ~ [wɔ:ɪ], Jasper [dadi]
1.8: water [waɪʔ] ~ [wadə], here [hɪ], ear [ʔɛ·]
1.9: butter [bu:], here [hɪ]
1.10: door [do], poor [bu], there [da], where [wə] paper [bubu], cover [da], streetcar [dɪdə], dear [dɪə], hair [hɛə], ear [ʔɪə], water [waɪu] ~ [waju] > [waɪu] ~ [wɔɪu], bear [bɛə], airplane [ʔeɪpi]
2.0: deer [dɪə], poor [pu]
2.1: where [wɛ]

Preconsonantal (nonsyllabic) r's are never represented, but if we assume the operation of the same processes as for final r's, we get the correct forms. There is compensatory vowel lengthening, at least optionally, when the [ə] is lost.

1.10: dark [da:t], (a)board [ʔabaʊ̯]
1.11 and 1.12: fork [hok] > [wɔ:k], New York [nɔjɔk]

One word is found which should have [$\overset{r}{w}$]. Instead of [o$^{ə}_{ʌ}$] → [u$^{ə}_{ʌ}$], which we would expect, [uɪ] is found.

1.10, 1.11: church [dʒuɪš]

This could be explained as a fronting of the [ə] before the palatal [š].[25]

Most postconsonantal r's leave no trace in Hildegard's speech. However, one word, pretty, is found early with [r] or some substitute, usually [w].[26] If this is considered to be an exceptional word, ahead of its time, then the other forms can be explained by the operation of Labialization, Deretroflexion, Raising, and Glide Loss.

1.1: Gertrude [də:di], pretty [pwɪti] until 1.8
1.5: (tooth)brush [bə] ~ [ba]
1.6: >[buba]
1.7: cracker [gaga] [k$_x$ak$_x$a]
1.8: brush [ba], grandpa [ŋæŋæ]
1.9: pretty [pɪti] > [pwɪti], broke [bok'] > [buk']
three [wi], ice cream [ʔaɪti] > [ʔaɪti]
1.10: toothbrush [tusba(ɪ)š], break [bek], broke [bok'] cry, dry [daɪ], crash [daš], dress [daš] ~ [dɛš] drink [dɪk], cracker [gago], brush [ba(ɪ)š], three [wi]
1.11: drink [dik(ç)], pretty [bɪdi], broke [bʊt'] [bok'] three [wi], cry [dai] ~ [daɪ], train [te], dry [da(·)ɪ] through [du] ~ [fu], crash [daš], toothbrush [tušbaš] dress [daš], scratch [daš], streetcar [dɪda] throw [do], ice cream [ʔati]

2.1: scratch [das̆], crash [das̆], throw away [wowe], three [wi]
2.2: crash [dats̆]

The forms for three and throw away indicate a limiting of process B, Glide Loss, although it still applies in most words.

Intervocalic r, R are usually omitted, although [w] occurs in English all right at 1.10. In all other forms Glide Loss is operating as well as R1, R2, and A. These processes (or assimilation in a few cases) give the following forms:

1.4: Marion [mɛmɛ] > [meme] at 1.5 > [mæmi] at 1.8
1.8: ironing [ʔaɪnɪ] > [ʔaɪŋɪ] ~ [ʔaɪnɪ] at 1.9
1.8: all right [ʔaɪaɪ] > [ʔa'wa] at 1.10
1.11: wheelbarrow [wibaʊ], Theresa [tita] > [dita]

4.3. Charles and Edmond Grégoire

My information on French-speaking children is from Antoine Grégoire's (1947) records of his two sons, Charles and Edmond. Concerning l's, [w] and [u] are never found as substitutes. Either l is represented as [y] or it is lost entirely. Apparently the l's in the children's model are "light". Process L1, Labiovelarization, is suppressed entirely by the children. Then Loss of Coronality (part b) and Delateralization (part b) and Strengthening give most of the correct forms.

Grégoire says (1947:317) that the consonant l began to be established at the end of the second year, in spite of the occurrence of [y] as a substitute. It was often found initially in articles, but was least sure at the end of words. Edmond says cha:-y for Charles and sa-ye for sale, and Charles says tou (or lou) for clou. At the beginning of the third year, l became an integral part of the phonology. In Grégoire's words (1947:317), their task was to "get rid of old habits of substituting [y] and to get rid of the suppression of l in consonant groups." Or, in my analysis, their task was to suppress the processes of Loss of Coronality, Delateralization, etc. Certain frequent words resist. For example, Charles says ayumette at 2.2, and soda:t at 2.3, but this becomes soldat at 2.4. Peut persists for pleut at 2.4, but pleure appears at 2.2.

Groups of consonant plus l appear early in Charles' speech. L2b and L3b are beginning to be suppressed for postconsonantal l's.

2.1: glaisse
2.3: bluwe, blu:le, blanc, but pafond for plafond until 2.7
clou, vla for voilá
2.4: mèle for merle
2.5: lwi for celui le
2.6: Chales for Charles
2.10: pleut
2.11: compliment

For Edmond:

2.2: clef is ké > kyé at 2.3 and 2.5
2.4, 2.5: plaît is pai:t
2.5: mirliton
2.6: fleur, but tablier is tabiye
2.10: perle

These forms indicate that Glide Loss is being limited for Edmond in postconsonantal position, and the words with correct l's indicate a limiting of Loss of Coronality.

For postconsonantal l's in word final position, the processes are still operating.[27] They give:

2.3: siffle > sif, couvercle > couverc
2.6: epingle > èpink

For Edmond, the processes as given also account for his treatment of preconsonantal l's.

2.5: soldat > todat, (but pal [e] tot at 2.4 is an exception)

For intervocalic l's, L2b, L3b, and Strengthening give these forms. B, Glide Loss is limited as below.

2.2: boule > bouye, sale > sa:ye, escalier > càyer

These same processes, except optional Glide Loss give the forms with initial l's, although loup has a correct l, indicating that the processes are being limited in initial position.

(B) $\begin{bmatrix} \text{glide} \\ \text{-Rnd} \end{bmatrix} \rightarrow \phi \; / \; \left\{ \begin{matrix} V\_\_C \\ C\_\_\# \\ .Co\_\_V \end{matrix} \right\}$ optional

2.2: lion > iyon, éyon; loup
2.4: liège > yè:sse

Concerning r, Grégoire (1947:345) writes that "Charles et Edmond se montrent pendant toute la troisieme année refracteures à l'emploi normal de cette consonne." He says that the primary reason for that resistance is the weak audibility of the liquid. If it is not vibrated, it lacks clarity, and some languages or dialects abandon it precisely where Charles and Edmond have omitted it most frequently: final r in non-accented position, as in popular French (chambre > sambe at 2.5, etc.).

According to Grégoire's account of the development of the acquisition or r, Charles used the word drôle often and thus the r is conserved. At about the same time (2.5), he started using

re for several words. Its use favored keeping the initial r. Finally, a "phonological necessity" imposed the presence of r in the forms of the future: iras, fera, etc. These forms started to be used more toward the end of the third year, just when the liquid entered into usage with less irregularity. The r appeared not only between vowels (as in fesaras at 2.8 and ira at 2.9) but even in groups with an initial consonant, as in f[e]ra at 2.7, donn[e]ra at 2.8, and s[e]ras.

There are a few words in which r → w, indicating the operation of processes R1, R2, etc., and occasionally r → ə, indicating the need for R2b, but usually r → ∅ or r → y.[28] The substitution of [y] for [r] is probably because of the concave and forward tongue position characteristic of French. This seems to make the r's palatal. Therefore, Process R1, Labialization, is nearly suppressed but a process of Palatalization is operating. It would be formulated as follows:

(R'1) $$r \rightarrow [+\text{front}] \quad / \quad \left\{ \begin{matrix} \{\#\\ V\} \\ .C \end{matrix} \right. \_\_ V \quad \text{optional}$$

Then there must be an additional part to R2, Deretroflextion:

(R2d) $$\begin{bmatrix} r \\ -\text{cor} \\ -\text{Rnd} \\ -\text{Bk} \\ +\text{Retr} \end{bmatrix} \rightarrow \quad i$$

This [i] would become [y] by Process C or would be absorbed by Process B in the appropriate positions.

partie > payti,[29] encore un > a:coy-une

Many words of daily usage were deprived of r in the first half of the third year (i.e. all processes were operating), but in the last half the processes are partially suppressed, and more r's appear.

train > tain, Thérèse > tèè, armoire > am:a, tatine, kè:me

For initial r, all processes are operating in Charles' speech, although yuw for rue indicates that B, Glide Loss, is optional in initial position. Deretroflexion is suppressed in initial position at 2.7.

2.1: rue > uw ~ yuw
2.7: ruw, raser

For Edmond, all processes operate at 2.1. At 2.5 and 2.6, Deretroflexion is optional, and at 2.7 it is suppressed.

2.1: raisin > èzin, rasoir > aza
2.5: rò:be
2.6: ruw, ró:sse ~ ó:sse
2.7: renverser, regarde, etc.

For intervocalic r's, in Charles' speech all processes apply at 2.0, except that Glide Loss is optional in intervocalic position. By 2.1, Glide Loss is suppressed, and by 2.5 Deretroflexion is nearly suppressed. A few words at 2.7 indicate that the processes are still opearting optionally, but all processes are suppressed by 2.9.

2.0: couonne, couyi:r
2.1: Charette > Say-ette
2.3: Désirée > Zi:yé:y
2.4: curé, patira, baraque
2.7: sau-ais, ca-oussel, baraque
2.9: ira, courir

In Edmond's speech, the forms with intervocalic r indicate that Labialization and Palatalization are applying in competition, since some w's and some y's are found. Glide Loss is nearly suppressed, except for the forms at 2.3 and 2.4.

2.2: Charrette > gayette ~ cayette ~ cawette ~ cawyette
enco-y-une, Désirée > Zi:yéy, Dèsiyé:,giraffe > iyafe
2.3: Paris > Païs
2.4: Charrette > Saette
2.6: souris, courir, pourr:ir, déchiré, p[l]èuré

For final r's, Deretroflexion and ə-Absorption account for many of the forms in Charles' speech, but these are partially suppressed quite early, since some correct r's occur at 2.1. By 2.8, the processes are suppressed entirely.

2.1: rasoir, asa:r, fière > fè:re, odeur, acore, faire, vicaire, bwiyère, but pou, fai
2.2: bruyère, bwiyère, pleure, voiture, au revoir > avwar, but su, pa, facteu(:), fai, touzou, pou
2.3: fé:re, but tombou
2.4-2.6: pou, tard > ta:, encore > cò:, terre > tè:, bonzou, fateu, noi, bonheu, voi, su, but fière > fér, (r)asoir

In Edmond's speech, Deretroflexion and ə-Absorption operate in most words until the fifth or sixth month of the third year. At 2.6 about half the forms have final r, and at 2.7 most final r's are correct. By 2.9, the processes have been suppressed.

2.1: encò
2.2: confiture > tatu, abat-jour > à bazou, but voiture, chasseur > sassar

2.3: voir > va, encore > enco, boire > boi
2.4: zou, pou, but beurre
2.5: voitu:u, guerre > guè:, but ceinture, terre, noir
2.6: jou, sur, boire, à terre
2.7: cour, sur, but pou
2.9: fleur, pour, etc.

No substitutes (except zero) appear for preconsonantal r. Therefore, Deretroflexion and ə-Absorption are operating. In some cases the preceding vowel is lengthened. The processes are beginning to be suppressed at 2.5 for Edmond and are completely suppressed by 2.7, but Charles is slower. Éternuw appears at 2.4, but it is well ahead of its time, and real suppression of Deretroflexion in preconsonantal position does not take place until 2.9 and 2.10. Edmond:

2.2: parti > ta:ti, garçon > taçon ~ daçon, Mariette > ayette, Marteau > ateau, chariot > cayòt
2.3: apò:tez, mèci, pati, rien > yien, but garçon
2.4: a:moi:, fémé:, chayòt, canet, gaçon, vète, code
2.5: zadin, sayòt, domir, but sariot, partir, mor queur
2.6: sayot, garçon ~ gaçon, fermé, farceur, jardin, carnet, corde
2.7: personne, jardin, parti, tiroir

Charles:

2.1: bardaf > badaf, domez-vous, fémez, mateur, bergère > bèzere
2.2: ja:din, dòmi:r
2.4: sò:ti, ega:dez, pòte, pati, mèci ~ mè:ci, mòceau, but éternuw
2.5: cherché > sésé, partie > pati:y, cobeaux, merle > mel
2.6: canet,[30] Irma > Ima, tournez > tounez, partira > patira
2.7: moceau, pati, zounal, renvé:sé, but cordon
2.9: partir
2.10: ga:dez, but borduw
2.11: armoire > amoire

Postconsonantal r's often do not appear at all, but are sometimes represented by [w] and sometimes by [y]. Edmond has suppressed the Labialization process for postconsonantal r's, and [y] usually appears. Charles, however, has suppressed the Palatalization process, and [w] is the usual substitute.

For Charles, Labialization, Deretroflexion and Glide Loss apply at 2.1. At 2.2, Glide Loss is being limited, and at 2.4 Deretroflexion also is slightly limited. At 2.5, all processes apply in some words, and in other words no processes apply. The processes appear to be optional at 2.6, and at 2.8. Deretroflexion has been suppressed.

2.1: bouyette, fè:r, l-a:b:icot
2.2: brouillard > bouyard, près > pè, atapé, but bwiyère
2.3: kèyon, mètte, pè
2.4: touver, kèyon, pendre, taval, dòle, coque, gand, agafe, but prener
2.5: peut-è:te, mette, tompette, dòle, apetèz-vous, but train > touwain
viendra > vindra, reluira > reluisra, grande, cême
2.6: br:un, gr:and, pruneau, prender, frère, but dòle, Kè:yon, Kè:me, chambre > sambe, pauvre > pauf
gand ~ grand, ouvi:, reluire > reluisa, viendra > vindra
2.7: doñra, frère, grant, grandez, bras, dròle, pendu, caoussel, touer, tain (later krain) ~ trwain, frwère, gwand'maman, tremper > tremprwer
2.8: frère, dròle, fraise
2.9: François, dormira > domra, but éki:re
2.11: prendu, près, etc.

In Edmond's speech, more variation appears. All processes apply at 2.1. At 2.3 Glide Loss is slightly limited; Labialization occurs in one word; and one word occurs with a correct r, but it is exceptional. The same situation obtains until 2.7, when Deretroflexion is beginning to be limited, and some correct r's appear. By 2.10 all processes are suppressed for postconsonantal r's in Edmond's speech.

2.1: trésor > téso, croûte > coute
2.2: tom^{m}pette, crayon > ki:yon, kè:me, bosse, but train, tram > t^{ch}yin, t'in, tch'am, tchyam
2.3: train > tyin, but
kèyon, tiyon, gain, agafé:, chêvre > se:fe
bras > bwa
bretelle
2.4: train > kyin ~ tyin, trou > syou
gedin, coute, tram > kam, champe, encre > enke
2.5: kèyon, pati:y, acòche, aute
2.6: tompette, kèyon, dòle, but
train > tyin
bras > bwa
2.7: aut', gòsse, doite, temper, giyé, o:gèsse, étier, but trou > tyou (later trou), but
train > terain (later train), griyé:, prend(re), gròs, degrés > decrés, étrier
2.8: crouts, but tanquille
2.10: crouts, krand, etc.

4.4. Moscowitz

Arlene I. Moskowitz (1969, Mzb) in a study of the acquisition of English phonology, reports that in one child, Mackie, /l/ and /r/ are fairly stable, although both are quite often omitted in final position; and [w] is the most frequent substitute for both. Another child, Erica, however, is "unable to maintain her articulators in a finely adjusted position (and holds the articulators too closed, among other things)," and this leads to converting many of the l's to a j-like quality. If /l/ is not correct or does not occur in its "opener" form as [j], it is omitted (as it often is in clusters), but it is never [w]. So, Erica has suppressed Labiovelarization, and all her l's are "light." Mackie, on the other hand, has the unlimited form of Labiovelarization of l's and Labialization of r's, since [w] is the frequent substitute. Erica:

> the leaf [dəˈʃjf], it's yellow [iˑjɛˈəo], puddle [pʰədəˈ] ~ [pʰə́dəo], balloon [bəjún], eleven [iˑjevɨ̌n], fly [faˑi] ~ [fiˤˑj], playground [pʰeˑjgˈəənd], Arlene [aˈjʃˑn], poor Leslie [pʰɔˈˑesjʃ̌j]

The r's in playground, Arlene, poor Leslie above are correct, as they are in frog [fˈaʌˑg], cars [kʰaˈsˑ], and beer [bʃəˈ]

5. Summary of Processes and Their Limitations; Conclusion

L1. Labiovelarization

$$l \rightarrow \begin{bmatrix} +\text{Rnd} \\ +\text{velar} \end{bmatrix}$$

This is limited to

$$l \rightarrow \begin{bmatrix} +\text{Rnd} \\ +\text{velar} \end{bmatrix} \quad / \quad [\ ]\ \_\_$$

by Daniel, Suzanne, Eleni, Jennifer, Joan (except that some intervocalic l's are excluded), and Hildegard (except that Labiovelarization is optional for her in intervocalic and word final positions).

This process is entirely suppressed for Erica, and Charles and Edmond Grégoire; Mackie has it in its unlimited form.

L2. Loss of Coronality

$$[+\text{lateral}] \rightarrow [-\text{coronal}]$$

i.e. a) $\begin{bmatrix} +\text{velar} \\ +\text{Rnd} \end{bmatrix}^{l^w} \rightarrow \hat{u}^{l}$

Jennifer limits this part to

$$l^w \rightarrow \hat{u}^{l} \quad / \quad \left\{ \begin{matrix} f \_\_ V \\ \_\_ \left\{ \begin{matrix} C \\ \# \end{matrix} \right\} \end{matrix} \right\}$$

b) $\begin{bmatrix} -\text{velar} \\ -\text{Rnd} \end{bmatrix}^{l} \rightarrow \hat{i}^{l}$

Daniel limits this at 1.6-1.7 to

$$\begin{bmatrix} -\text{velar} \\ -\text{Rnd} \end{bmatrix}^{l} \rightarrow \hat{i}^{l} [-\text{coronal}] \quad / \quad \_\_ \begin{bmatrix} +\text{High} \\ V \end{bmatrix}$$

L3. Delateralization

$$\begin{bmatrix} -\text{cor} \\ -\text{son} \\ \pm\text{velar} \end{bmatrix} \rightarrow [-\text{lateral}]$$

i.e. a) $\begin{bmatrix} \overset{\wedge}{son} \\ +\text{velar} \end{bmatrix}^{\hat{u}^{l}} \rightarrow \hat{u}_{[-\text{lateral}]}$

b) $\begin{bmatrix} \overset{\wedge}{son} \\ -\text{velar} \end{bmatrix}^{\hat{i}^{l}} \rightarrow \hat{l}_{[-\text{lateral}]}$

The children limit and suppress these earlier in some positions than in others.

R1. Labialization

$$\begin{bmatrix} r \\ \pm\text{syll} \end{bmatrix} \rightarrow [+\text{Rnd}]$$

This is limited to

$$\begin{bmatrix} r \\ \pm\text{syll} \end{bmatrix} \rightarrow [+\text{Rnd}] \quad / \quad \left\{ \begin{matrix} .\text{Co}\_\_ \\ +\underline{\text{stress}} \\ V\_\_V \end{matrix} \right\}$$

by Daniel, Suzanne, Eleni, Melissa, Jennifer (although no examples of intervocalic r appear), and Hildegard (although it is optional for initial r's).

Mackie has R1 in its unlimited form. For Joan it is slightly limited in final position and does not apply intervocalically. Edmond and Charles have nearly suppressed R1.

R2. Deretroflexion

sonorant → -R

i.e. a) r, w → o̯

-coronal
+Rnd
+Bk
+Retr.
-stress

b) r → ə

-cor
-Rnd
+Bk
+Retr.
-stress

c) ŕ, w → ɔə̯

-cor
+Rnd
+Bk
+Retr
+stress

The subparts of this process become optional or are suppressed at different times in the different positions in words.

A. Raising

+voc
+Rnd
+Bk

→ [+High]

i.e. a) o̯ → u̯

b) oə̯ → uə̯

No specific limitations are found.

B. Glide Loss

Glide
±Rnd

→ ∅

Dnaiel at 1.6-1.7 limited this as follows:

+Rnd
glide

→ ∅ / { V__C , .C__V } a) b)

Part b was limited right away

±Rnd
glide

→ ∅ / { V__C , . [-cor cons] } a) b)

At 2.5 part a was limited

$$\begin{bmatrix}+\text{Rnd}\\ \text{glide}\end{bmatrix} \rightarrow \phi \;/\; \left\{\begin{array}{ll}\begin{bmatrix}+\text{High}\\ +\text{Bk}\\ \text{V}\end{bmatrix} & \_\_\text{C} \quad \text{a)}\\ \\ \begin{bmatrix}-\text{cor}\\ \text{cons}\end{bmatrix} & \_\_\text{V} \quad \text{b)}\end{array}\right.$$

Suzanne has this same limitation of (a) at 2.10, as did Joan at 1.1 (except that a consonant does not have to follow).

Eleni, Jennifer, and Joan limited it to

$$\begin{bmatrix}+\text{Rnd}\\ \text{glide}\end{bmatrix} \rightarrow \phi \;/\; \left\{\begin{array}{l}\text{V}\_\_ \left\{\begin{matrix}\text{C}\\ \#\end{matrix}\right\}\\ \\ (.)\text{C}\_\_\text{V}\end{array}\right.$$

Hildegard limited B to [+Round] glides at 1.5, as follows:

$$\begin{bmatrix}\text{glide}\\ +\text{Rnd}\end{bmatrix} \rightarrow \phi \;/\; [\ ]\ \_\_$$

then at 1.8:

$$\begin{bmatrix}\text{glide}\\ +\text{Rnd}\end{bmatrix} \rightarrow \phi \;/\; \left\{\begin{array}{l}[\ ]\ \_\text{V}\\ \left\{\begin{matrix}\text{o}\\ \text{o}\end{matrix}\right\}\ \_\_\\ (\text{a}\ \_\_)\end{array}\right.$$

The Grégoires limited B to [-Round] glides:

$$\begin{bmatrix}\text{glide}\\ -\text{Rnd}\end{bmatrix} \rightarrow \phi \;/\; \left\{\begin{array}{l}(.\text{C}_{\text{o}}\ \_\text{V})\\ \text{C}\ \_\ \#\\ \text{V}\ \_\ \text{C}\end{array}\right. \quad \text{optional}$$

C. Strengthening

$$\text{glide} \rightarrow [\text{-vocalic}] \;/\; \left\{\begin{array}{ll}.(\text{C}) & \\ \text{V} & \end{array}\right. \_\ \text{V} \qquad \begin{array}{l}\text{a)}\\ \text{b)}\end{array}$$

i.e. $\underset{\wedge}{\text{i}} \rightarrow \text{y}$
$\underset{\wedge}{\text{u}} \rightarrow \text{w}$

D. ə-Absorption

$$\underset{\wedge}{\text{ə}} \rightarrow \phi \;/\; [\text{vocalic}]\ \_\_$$

Daniel and Melissa have this process in a more limited form:

$$\underset{\wedge}{\text{ə}} \rightarrow \phi \;/\; \begin{bmatrix}+\text{voc}\\ +\text{Bk}\end{bmatrix}\ \_\_$$

Daniel limits it further to

$$\underset{\wedge}{\text{ə}} \rightarrow \emptyset \; / \; \begin{bmatrix} +\text{Low} \\ +\text{Bk} \\ +\text{Rnd} \\ \text{V} \end{bmatrix} \; \_\_$$

Eleni has it in the form

$$\underset{\wedge}{\text{ə}} \rightarrow \emptyset \; / \; \begin{bmatrix} +\text{Low} \\ +\text{Bk} \\ \text{V} \end{bmatrix} \; \_\_$$

and ə-Absorption is optional for her after all other vowels.

Hildegard has it in its unlimited form, although it is optional after 1.10.

5.1. Special Processes

R'1. Palatalization

$$\text{r} \rightarrow [+\text{front}] \; \left\{ \begin{matrix} \left\{ \begin{matrix} \# \\ \text{V} \end{matrix} \right\} \_\text{V} \\ (.\text{C}\_\text{V}) \end{matrix} \right\} \text{ optional}$$

Edmond and Charles have this process. Joan has the form:

$$\text{r} \rightarrow [+\text{front}] \; / \; \text{V} \_ \text{V}$$

before 1.11. Hildegard, at early stages, has the limited form

$$\text{r} \rightarrow [+\text{front}] \; / \; \# \; \_ \text{V}$$

R2d

$$\overset{\text{r}}{\begin{bmatrix} -\text{cor} \\ -\text{Rnd} \\ -\text{Bk} \\ +\text{Retr} \end{bmatrix}} \rightarrow \text{i}$$

Joan and Hildegard have this process early, and Charles and Edmond have it at all stages.

$$\text{a)} \;\; \text{y (or j)} \rightarrow [\tilde{\text{z}}] \rightarrow \left\{ \begin{matrix} \text{z} \\ \text{h} \end{matrix} \right\}$$

Joan has the first part of this process so that j → z. Hildegard has the second part at early stages, but it is optional (j → h / # __)

b) $\begin{bmatrix} \text{l} \\ \text{-Rnd} \\ \text{-Velar} \end{bmatrix} \rightarrow \text{n}$

Only Emily has this late change.

c) Vowel Adjustment

1) $\text{ə} \rightarrow \left\{ \begin{matrix} \text{i} \\ \text{I} \\ \text{a} \end{matrix} \right\}$ optional

Hildegard has these changes.

d) ə → a

Joan has this late process.

5.2. Conclusion

Although the exact form of the above processes varies from child to child, it can be seen that these processes of Labio-velarization of l's, Labialization of r's, etc., do account for most of the substitutions encountered in the speech of the children investigated. Thus the hypotheses made at the outset of the study have been verified: 1) A few basic processes seem to be taking place in the children's acquisition of liquids. 2) These processes are gradually limited and suppressed as acquisition proceeds. 3) Changes taking place in French and German children are slightly different (i.e. the processes are being suppressed differently according to the types of liquids found in the language). It will be shown in Appendix B that the fourth hypothesis, concerning historical change and dialectal variation, has also been verified.

In conclusion, it appears that the acquisition of at least this one segment of phonology, the liquids, can be explained quite well by the model which says that a number of innate processes are gradually limited and suppressed as acquisition progresses.

Appendix A

Processes in Their Strongest Forms

l

L1. Labiovelarization

$$l \rightarrow \begin{bmatrix} +\text{Rnd} \\ +\text{velar} \end{bmatrix}$$

L2. Loss of Coronality

[+lateral] → [-coronal]

i.e. a) $\overset{l^w}{\begin{bmatrix} +\text{velar} \\ +\text{Rnd} \end{bmatrix}} \rightarrow \underset{\wedge}{u}^{l}$

b) $\overset{l}{\begin{bmatrix} -\text{velar} \\ -\text{Rnd} \end{bmatrix}} \rightarrow \underset{\wedge}{i}^{l}$

L3. Delateralization

$$\begin{bmatrix} -\text{cor} \\ +\text{son} \\ \pm\text{velar} \end{bmatrix} \rightarrow [-\text{lateral}]$$

i.e. a) $\underset{\wedge}{u}^{l} \rightarrow \underset{\times}{u}$ before $\begin{bmatrix} \text{son} \\ +\text{velar} \end{bmatrix} \rightarrow [-\text{lateral}]$

b) $\underset{\wedge}{i}^{l} \rightarrow \underset{\times}{i}$ before $\begin{bmatrix} \text{son} \\ -\text{velar} \end{bmatrix} \rightarrow [-\text{lateral}]$

A. Raising

$$\begin{bmatrix} +\text{voc} \\ +\text{Rnd} \\ +\text{Bk} \end{bmatrix} \rightarrow [\text{High}]$$

i.e. a) $\underset{\wedge}{o} \rightarrow \underset{\wedge}{u}$

b) $o^{\partial}_{\wedge} \rightarrow u^{\partial}_{\wedge}$

B. Glide Loss

$$\begin{bmatrix} \text{glide} \\ \pm\text{Rnd} \end{bmatrix} \rightarrow \emptyset$$

r

R1. Labialization

$$\begin{bmatrix} r \\ \pm\text{syll} \end{bmatrix} \rightarrow [+\text{Rnd}]$$

R2. Deretroflexion

Sonorant → -R

i.e. a) b) c)

$$\overset{r}{\overset{w}{\begin{bmatrix} -\text{cor} \\ +\text{Rnd} \\ +\text{Bk} \\ +\text{Retr.} \\ -\text{stress} \end{bmatrix}}} \rightarrow \underset{\wedge}{o} \qquad \overset{r}{\begin{bmatrix} -\text{cor} \\ -\text{Rnd} \\ +\text{Bk} \\ +\text{Retr.} \\ -\text{stress} \end{bmatrix}} \rightarrow \partial \qquad \overset{\acute{r}}{\overset{w}{\begin{bmatrix} -\text{cor} \\ +\text{Rnd} \\ +\text{Bk} \\ +\text{Retr.} \\ +\text{stress} \end{bmatrix}}} \rightarrow \acute{o}^{\partial}_{\wedge}$$

C. Strengthening

$$\text{glide} \rightarrow [\text{-vocalic}] \; / \; \begin{Bmatrix} .(C) \\ V \end{Bmatrix} \_\_ V \quad \begin{matrix} a) \\ b) \end{matrix}$$

i.e. $\underset{\wedge}{i} \rightarrow y$

$\underset{\wedge}{u} \rightarrow w$

D. ə-Absorption

$$\underset{\wedge}{ə} \rightarrow \emptyset \; / \; [\text{+vocalic}] \; \_\_$$

Special Processes of Limited Application

R'1. Palatalization of r

$$r \rightarrow [\text{+front}] \; / \; \left\{ \begin{matrix} \begin{Bmatrix} \# \\ V \end{Bmatrix} \; \_\_ V \\ (.C \; \_\_ V) \end{matrix} \right\} \quad \text{optional}$$

R2d. Deretroflexion of palatal r

$$\begin{bmatrix} r \\ \text{-cor} \\ \text{-Rnd} \\ \text{-Bk} \\ \text{+Retr.} \end{bmatrix} \rightarrow i$$

a) y (or j) $\rightarrow$ ($\check{z}$) $\rightarrow \begin{Bmatrix} z \\ h \end{Bmatrix}$

b) $\begin{bmatrix} l \\ \text{-Rnd} \\ \text{-velar} \end{bmatrix} \rightarrow n$

c) Vowel adjustment

1) $ə \rightarrow \begin{Bmatrix} i \\ \text{I} \\ a \end{Bmatrix}$ optional

2) $\begin{Bmatrix} \text{I} \\ v \end{Bmatrix} \rightarrow ə \rightarrow a$ optional

d) $ə \rightarrow a$

Appendix B

Brief Survey of Similar Processes in Synchronic Alternation, Historical Change, and Dialectal Variation

Most of the processes found to be operating in the speech of the children do have parallels in historical change or dialectal variation. The major processes are found in several languages, and the less important processes have fewer parallels in historical change.

1. Processes affecting l

1.1. Labial Substitutes

Passy (1890:156, 157, 224) writes that a slight exaggeration of "grave l" (velar) gives [lˠ] and if this is then joined by labial action, [lʷ] results, "as we sometimes find in English." He says that this [lʷ] is very common in Slavic languages, and that:

> pour un son somme [lʷ], la modification labiovélaire n'est que l'accessoire; mais si elle est très forte, elle peut finir par être l'essentiel, et alors on la conserve seule sans articuler de [l]; ce qui donne [w] ou [u]. C'est ainsi que l'anglais rook... devient wuk.

Similarly, Grammont (1950:278) writes that, if a velar, especially at the end of a syllable, loses its "glissement latéral," a w is substituted naturally for it. Grammont (1950:207) explains the velarization of l between a vowel and a consonant as follows:

> The preceding vowel tends to increase the aperture of the l, and "d'autre part la consonne appuyée qui suit tendant à faire anticiper ses mouvements articulatoires, la pointe de la langue perd la fermeté de son point d'appui; la langue se détend et par suite sa partie postérieure remonte vers le voûte palatine. Le glissement latéral est donc reporté plus en arrière: c'est l'l vélaire."

That state is generally that of Latin. In French the evolution has continued, and the point of the tongue has definitely lost contact, The velar l has become [u] (i.e. *chevals > chevaus, etc.). The phase [u] has been preceded by a phase [uˠ], at the moment when the point of the tongue was only on the verge of losing

contact. That phase is conserved in "roumanche:" kau$^{\pm}$, au$^{\pm}$, au'ter. The English of the 16th century gives a further example: all, salt, talk were pronounced [aul], [sault], [taulk].

C.-J. Bailey (1969:270) discussed [$^{\pm}$] in American English dialects. He says that [$^{\pm}$] has a [ɯ] or [$^{\upsilon}$] quality and is articulated with the dorsum of the tongue against the teeth on one side of the mouth. Examples from Southern States English show the [u] vowel as in [bɒ$^{\upsilon}$|] for ball.

Wise (1957) also discusses the velarization of postvocalic l's in English. He says that "drawl dialects" draw out the l until it forms another syllable, and [ə] intrudes to augment the syllable. Fool becomes [fuə|], and in Eastern American call is [kɔə|]. In Southern forms the l drops, but velarization (and labialization) of the vowel is retained, and we find milk [mɪok], kill [kɪo], built [bɪoṭ]. The same process produced a vowel of a different height in Scottish English. Tollbooth is [tʌ$^{\upsilon}$buθ], ball is [bʌ$^{\upsilon}$]. The velarized vowel is dropped regularly after [a] in Scottish English, and scald is [skad], all [a], false [fas], awful [afu]. In Southern American and Negro dialects, the velarized vowel disappears in words like twelve [twəv], million [mijən]. This also happens in General American before j, r, and w, and volume is [vajɛm], already is [arɛdi].

1.2. Palatal Substitutes

Changes of l to [y] (or [j]) are common in the literature on historical change. Usually the change takes place via [l']. Grammont (1950: 81, 208) writes that 'palatalized' l's are very frequent. They are characterized by a large extent of the region of contact of the tongue, but vary greatly according to language and positions of the tongue. Grammont explains how an [l] can change to [i] in postconsonantal position, as in Italian chiave from claue, pieno from plenu, bianco from blancu, etc. He says (1950: 268) that the initial phenomenon is always the same, "affaiblissement par la voyelle de la position spécifique de la pointe de la langue," which takes a position more favorable to the following consonant.

> Dès lors ce n'est plus la pointe qui s'élève vers le palais, mais la partie antérieure du dos de la langue; c'est à peu près la position de [l'], à laquelle on aboutit instantanément.

In some regions [l'] is still preserved, for example in the mountainous dialects of Fribourg, and in many dialects [l] is palatalized only after palatals: chiang, but plin, blând.

Passy (1890:145) also gives the above example of ordinary l → [j] or [i] in Italian, and he says that it probably happened by the intermediary of [ʎ] or [l^{j}], but that, judging from the pronunciation of children, it could have been direct. He reports that the reinforcement of a transitory sound in [j] takes place after a palatal liquid [ʎ], which thus becomes [l+j]. This

happens in northern France and results in [bri·ʎje], [muʎje] for [briʎe], [muʎe]. In Swedish l, → j, probably by way of [ʎ].

Passy (1890:94, 158) also tells how laterals can become vowels if the passage of air is enlarged. When the passage is enlarged, the rest of the tongue occupies a determined position, and one hears the vowel corresponding to the last position modified by the particular position of the point of the tongue. Thus French acute l may become [j] or [i]:

$$[l^j] \rightarrow [ʎ] \rightarrow [j] \text{ or } [i]$$

Jakobson (1968:17) mentions that l (and r) change to [j] in the Russian dialect of Lower Kolyma, and also in the "love language" of Russian peasant women in Northeast Siberia.

Collinder (1965:88) reports that Mordvin intervocalic l has become palatal before front vowels:

$$*l \rightarrow l' / \_\_ \begin{bmatrix} +voc \\ +front \end{bmatrix}.$$

Collinder also says (1965:80) that in some of the Uralic languages reconstructed *l's developed into [j], before both front and back vowels.

Passy, who in 1890 was saying that "changes come from children" gives one example concerning l's (1890:233).

> Le changement d'l en l mouillé après une consonne, qui s'est accompli dans tant de dialectes romans, n'est qu'une prononciation enfantine rectifiée, prononciation qui aujourd'hui encore naît brusquement sous nous yeux, tels parents disant très nettement fleur, blanche, et leur enfant non moins nettement fleur, bllanche (j pour l mouillé.)

1.3. Nasal Substitute

The change of [l] to [n] which appeared in Emily Salus' speech is found less frequently in the data on historical change. However, Grammont (1950:208) does mention that in certain places in the interior of the island of Sicily l has become n before dentals. The anterior part of the tongue has taken in advance exactly the position required for the dental, and the l "n'a eu d'autre ressource pour sortir en glissement que de recourir à l'abaissement du voile du palais." Thus we find antru, santu, punsa, etc.

Often l → n is cited as a sort of assimilation (e.g. lincel → nincel in "le trécorois") or a dissimilation (e.g. Vulgar Latin cuntellu from cultellu) (Grammont 1950:278).

Thai has no syllable final l or r, and when these are introduced in loan words, n is substituted for them. This is also frequent in American Indian languages, e.g. Biloxi changes l from loan words to [n], and in Nootka, l has everywhere become [n]. In addition, [n] is sometimes substituted for liquids in "consonant symbolism" used in some Indian languages of the Northwest.[31]

Juang, a Munda language, also has undergone a process whereby l became [n] in certain positions so that buffalo, which is bəŋtɛl in Sora, and boŋtel in Kharia, is boŋten in Juang, and girl, which is ɔnsɛl in Sora and konsel in Kharia is boŋcen in Juang (Pinnow 1960).

1.4. Other Substitutes

In support of our claim that the substitution of z for light l in Joan Velten's speech involves several processes, there appear to be no examples of such an alternation or change in adult languages.

The confusion of l and h is mentioned in Grammont (1950:205). He writes that h has a

> point d'articulation vague sur la moitié antérieure du palais, du sommet de la voûte aux dents. L'h est un phonème à glissement articulé dans la meme région. La confusion acoustique entre les deux est facile; la différence articulatoire est minime, l'h en question étant une sorte d'l articulé avec la pointe de la langue vers le bas.

2. Processes Affecting r's.

2.1. Labial Substitutes

Passy (1890:156) discusses the labiovelarization of r's.

> cette concordance des actions labiale et vélaire... Ainsi le [ɹ] anglais se prononce souvent [ɹʷ] Il n'est pas rare que ce [ɹ] se transforme en [w] (surtout devant les voyelles vélaires): rook [wuk], horses [ɑɹʷsɨz].

If a French velar r is prolonged and accompanied by labial action [ʀʷ] results (Passy 1890:48, 147, 156). In Parisian French [ʀ] tends to be velarized and changed to [qˠ], which can then become [w]:

$$[q^{ɹ}] \rightarrow [q^{ʋ}] \rightarrow [ʋ^{q}] \rightarrow [w]$$

In some French dialects r becomes a voiceless velar fricative

and then eventually [w]. Similarly, German uvular r, if rounded, may become [w] by way of a velar spirant.

2.2. r → ə (or a)

About the change of r to [ə], Grammont (1950:77) says:

> Quand la fricative est un sonore, si l'aperture augmente et que la pression diminue légèrement, on n'entend plus que les vibrations laryngiennes, à moins que la disposition des organes ne fournisse un résonateur propre à l'émission d'une voyelle. Ainsi en anglais dans certaines positions particulièrement à la finale, l'r devient [ə]: dear [dɪə] father [faðə]. (Cette voyelle [ə], articulée un peu en avant du sommet de la voûte palatine, est une sorte d'a dans divers dialectes: dans certains parlers d'Allemagne du Nord der Vater → [dafata], der Berger → [dabaga] c'est bien un a mas ce n'est pas l'a ordinaire de ces parlers; c'est un a qui a le timbre de l'r qu'il remplace.

Passy (1890:94) tells how all fricatives (including r) can become vowels when the passage is enlarged. The tongue occupies a determined position, and one hears the vowel of the past position, modified by the particular position of the point of the tongue. Thus we get [ɪʲ],[oᵇ],[rᵃ], etc. These sounds do exist in some languages, for example [ɑʲ⊥],[ɔʲ⊤] in English dark and lord and [rʲ] in Russian.

There are many such examples from contemporary dialects in C.-J. Bailey (1969:250-253). He says that [ɹ̩] before consonants and word boundaries loses its retroflexion and becomes [ə]. One may hear seer as [sɪ-ə] or [seᵊ:], ewer [yu-ə], cart [kʰɑ(ə):t], horse [hɔ(ə):s], were [wɛᵊ:] (in British English). In the deep South boor, bore, pure, four, etc., have [oᵊ:] or [wᵊ:]. In short, tort [ɔ(ə):] is often heard. Iron in some dialects may be [ɑᵊ(:)n].

2.3. Loss of r

Loss of intervocalic r, as found in some children, is reported in Vulgar Castilian Spanish (Castro 1924:12). Quiero is [quió] fueras [fuás], etc.; and in Andalusia r is lost in traélo, llaválo, for traerlo, llevarlo.

Jakobson (1968:14) mentions the loss of r before consonants in Russian children (with a lengthening of the vowel), so that marka "mark" is [ma:ka].

2.4. Palatal Substitutes

Grammont reports (1950:209) that in Andalusia r → y and from there becomes [i], the second element of a diphthong:

porquero → poiquero, largo → laigo. He presumes that there would be an intermediate step of palatalized r [ɹʲ].

As mentioned previously r (and l) change to [j] in the Russian dialect of Lower Kolyma, and in the "sweet talk" of Russian peasant women. Jakobson (1968:17) also mentions that this change occurs in Grammont's 2-year-old son, who took the pronunciation from his younger sister and generalized it through his whole vocabulary.

2.5. Other Substitutes.

There are examples of the change of r → z in the literature, although the opposite change of z → r (rhotacism) as in Latin in intervocalic position, or in the Germanic languages, is more common.[33] Passy (1890:147) mentions the change of r → s in French, as in chaire → chaise. He supposes [ɹʲ] as an intermediate step, which still exists in some areas. Grammont's explanation (1950:74) of the change of r to z is as follows:

> Si les organes ne sont pas assez rapprochés pour que le tremblotement se produise, l'air s'écoule d'une manière égale entre ces organes et les r qui en résultent sont bien alors des liquides et des spirantes. C'est à tel point qu'il leur arrive de se confondre acoustiquement avec d'autres liquides ou d'autres spirantes. Ainsi l'r alvéolaire sans battements se confond aisément avec une certaine nuance de z: roussillonnais sastre < *saztre < sart(o)re.

In Turkic reconstructed *r^{ə} (intervocalic) developed into z (Poppe 1965:197). Manchu iri, Mongolian ir, Chuvash yĕr, ancient Turkic iz "trace."

The minor change of r → h which appeared in Hildegard Leopold's speech has a few parallels in historical change and dialectal variation. Grammont (1950:278) writes that posterior aspiration is a very satisfying replacement of a velar or pharyngeal r; thus Arabic sarsá "cacher" arises from sarsar. Grammont says that any r whatever can:

> aboutir par dissimilation à une aspiration. Se cette aspiration est mal caractérisée ou si le système phonique n'en comporte pas, c'est l'amuissement, le résidu de l'r dissimilé n'ayant pas pu prendre corps sous forme d'un autre phonème existant.

Castro (1924:12) reports a change of r to h in the Andalusia dialect of Spanish: carne > cahne, virgen > vihen, etc.

Footnotes

1. "Frequency" may not be the best term to use here, but it indicates simply that the number of forms in which a process is applying is becoming progressively smaller. The process is still optional, but it is applying to fewer forms.

2. At this stage (2.11) horses is [hoə̯ˠsɨz], with [oə̯] like Daniel had. The r off-glide may indicate that we need another rule, between Labialization and Reretroflexion, parallel to L2, Loss of Coronality. This would give a stage like [oə̯ˠ], etc., parallel to [uˠ] [iˠ].

3. Suzanne inserts epenthetic [ə] here, as Daniel did.

4. Daniel occurs once at this stage as [dǽnəl], which is far ahead of its time, perhaps because it is such a frequent word.

5. [wáɻn] also appears for this word, indicating the unlimited form of Labiovelarization, but it is the only such form found for Eleni.

6. It is impossible to tell what is happening with intervocalic l's, since telephone is [dɛ́fon], color [kʌ́də], dollie [dɔ́dɨ].

7. Light occurs once as [zʌ́ɻt]. This is interesting in view of later data on Joan Velten.

8. It should be noted here that since Melissa's model is a Northeast r-less dialect, probably R2b and D will never be suppressed in final or preconsonantal position.

9. For the word for animals we need a rule lowering [u] to [o] in this particular environment.

10. All postconsonantal l's were unrepresented in Jennifer's speech a year earlier. I do not know why Loss of Coronality has been so strangely limited at this stage.

11. Cry occurs at this stage as [kwáɹ], indicating that B, Glide Loss, is being limited.

12. There is independent evidence for this process since the only word with an initial y in the model has a [z] in Joan's speech: yard [za·d].

13. Lunch also occurs as [nʌts] but this is explainable by assimilation, as are [bap] for lamb and [nan] for lion.

14. Since Velten is writing phonemically, he uses w for the [u] in word final position after a vowel. I am treating them as equivalent in this position.

15. Joan often lengthens vowels when the glide is lost, both for l's and r's.

16. Postconsonantal r's in French words are treated the same at this stage, e.g. [dus] is found for gris.

17. At 1.11 to 2.3 French uvular r is [z] as in Raoul [zaw] Montreal [mazua'] (from [mɔ̃reɑ'l]). At 2.0 prends garde is [zadad]. English pr would be a simple labial stop at this stage. Gaberell Drachman says that the [z] for r is due to the fact that the tongue tip is down for French, and the child lacks tongue tip control at this early stage.

18. For Karla, Hildegard's younger sister, [j] was a less common substitute, although [jɛk] was found for lake at 1.10.

19. Liebling is [wɪtɬ] at 1.11. Leopold interprets this not as a real substitute, but as a blend with Fritzchen or sweetheart. Karla has [ɬpɬ] ~ [ɬptɬ] at 1.11, with omission of the l.

20. Leopold quotes other studies in which [ɪ] is found for German l. For example, in footnote 35 (Leopold 1939:26) he quotes Ronjat, who says that Ball may be [bay].

21. Leopold (1939:65) says that Karla's regular substitute was [u] at 1.10 and 1.11 in apple, purple, [ɔ] in bicycle. People was [pɨpɨ] at 1.10. She omitted English and German l in all, call, nail, bell, etc.

22. In footnote 175 Leopold (1939:70) says that Kenyon (p. 221) gives [ʷ] for l, giving [mɪʷk] as the common form for milk, but he also mentions that [mɪək] is found.

23. Karla also had sl → j (Leopold 1947:67).

24. Although I did not find such variation in my work, it is evidently not uncommon. In footnote 186, Leopold says that Holmes (p. 221) notes that r → ə in bear from 1.7 to 1.11, but Holmes gives [a] as another substitute. Also Karla has [ɪ] occasionally as in [hɛɪ] for hair at 1.10.

25. Karla (Leopold 1939:136) at 1.10 had [hoət] for hurt, which is what we would expect to get by processes R1, R2c, and A.

26. [pytɬ] also appears occasionally at 1.4 and 1.5. Similarly, Karla has [pyɨ] at 0.9 and [pytɨ] at 0.11. These forms can be explained by optional Palatalization of r and Deretroflexion. The Palatalization process is given in Appendix A.

27. Since postconsonantal word final l is usually unrepresented in popular French, these processes may never be suppressed for l's in that position, although the usual explanation is that such final l's are devoiced and then lost (e.g. tabl → tabl̥ → tab).

28. Occasionally r → l as in brûle > bluwe at 2.1 and blu:e at 2.5.

29. pa:ytɬ is a variant. Early attempts at r sometimes result in such an elongation of the preceding vowel, regardez > a:dez.

30. Grégoire (1947:305) says that when asked if he said canet, Charles responded, "No, ca-net" (with a slight pause).

31. Consonant symbolism is a deliberate change of sounds, frequent for some kind of diminutive or derogatory speech, or when speaking to children (Mary R. Haas, personal communication).

32. Grammont (1950:293) mentions a change of z → i before a sonorant in "roussillonnais" (e.g. *azbre > áibre, etc.).

33. Arnold M. Zwicky (personal communication) says that we should not discount the possibility that an apparent change r → z is really the reappearance of an underlying z.

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